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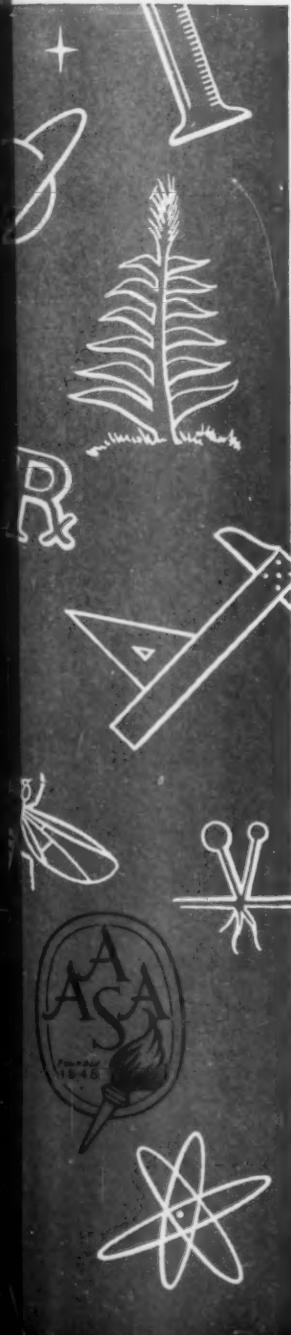
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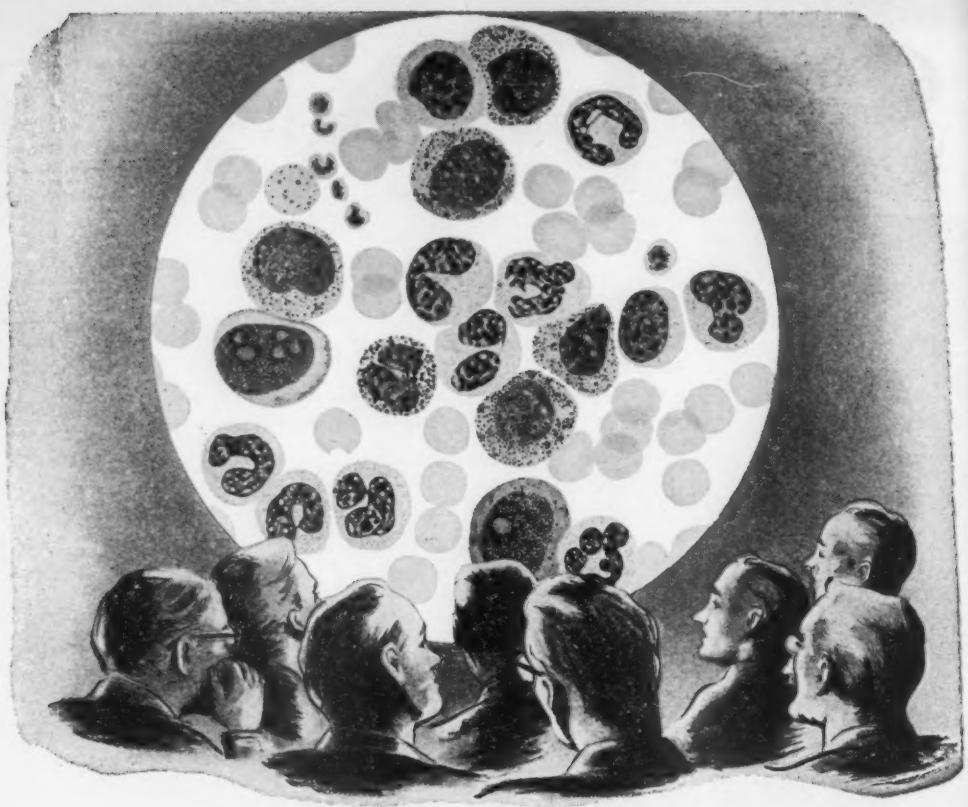
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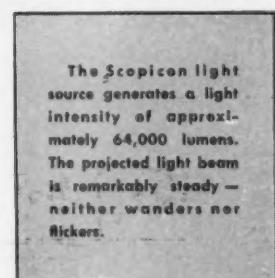


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March

# Support of the Individual in Basic Research

Paul H. Kratz

2800 Quebec Street NW, Washington, D.C.

THE project method of support, the block grant, and other methods of research support have various virtues but share at least one disadvantage in common. They do not deal directly with individuals, but with institutions. One knows that really an award is made to an institution only because of the ability and availability of a certain person associated with that institution. True, the institution offers him research facilities and a favorable (in most cases) atmosphere for the prosecution of his research. However, there is no guarantee that this sort of support through such channels is necessarily the best.

An individual of outstanding ability or one possessing the potential ability must be free. What can make him free? If we take what we may consider to be the ideal teacher-scientist or scientist-teacher, we must allow him to have access to the best and broadest training possible. When he has completed his formal training and is entirely dependent upon himself and his contacts with fellow thinkers for future growth, we must allow him to have freedom in such areas as choice of work, choice of content, and choice of atmosphere. We can only request that he shall in some degree be useful to his fellows in the exchange of ideas, and to younger men by such teaching as he may be capable and desirous of doing. It must be up to the man himself to determine which of these two functions he will stress in his career.

A charge may be leveled against many of our present educational institutions, namely, that they no longer are guided by their faculties. To fulfill its mission of being a repository of culture and to fulfill its duties of education, research, and public service, a university must be quite conscious of the value of faculty planning and guidance. At one time the faculty in itself was the university, and learning flourished under such conditions. Today we have the administrator, the aura of big business, and the research-foundation-type of institution. If this be the typical institution of the future, we are perpetuating a growing menace to our islands of learning by channeling the nation's funds through such processing machines. Lack of faculty control may be the reason for the imbalance of education and research, the imbalance of kinds of research, and the stagnation of curriculums, and apparently the inability to make our product quite as good as the European scholar.

If this be so, let us support the individual, whoever or wherever he may be. Let us draw up a system of education and research support for persons who prove themselves worthy of it. As an example, look at the very small program of the American Heart Association. For a person who wishes to train and work in

this area, funds and support are provided in four different fellowship categories: junior, senior, independent investigator, and career fellowship. These provide for training prior to receiving the M.D. or Ph.D., postdoctoral support, research support, and long term research support, respectively. Together, all four programs can carry a person through his entire career and can finally lead to retirement on a level at least as good as standard retirement. In the actual working of such support, the man finds an appropriate atmosphere with which to affiliate himself. He is obviously of service to his faculty home; the only restriction is that he may not teach more than 25 percent of his time. In addition to his salary, he receives some small support for equipment and materials. The career investigator grants are for five-year periods and renewal depends upon the interests of the individual, his desire to stay in some section of this field, and his demonstrated ability and activity.

Thus we have an individual who has chosen his own field, who is not subjected to any institutional or governmental pressures to divert himself to applied problems, who teaches that which he believes himself best fitted to teach, and who is not forced to worry at extremely short intervals about his future. Such freedom, placed in capable and mature hands, appeals to one as being a worth-while goal indeed. An analogy to democracy may be seen here—the combination of personal freedom and personal responsibility, both leading to and enhancing the common good.

This same principle could be carried out on a much wider scale on a national basis. At the present, research and education are supported by various government and private agencies, by means of two separate but related programs. Would it not be feasible that these two aspects of support be merged into one whole by the supporting agency? Fellowship applications are received from individuals; the fellows are selected by a group of men whose interests and accomplishments are close to those of the individual applicant; awards are made that leave the fellow free in all cases to choose his field and location in which to work. Likewise, in research support, an individual proposes work best suited to himself (unfortunately, sometimes with overtones of what he thinks may be attractive, timely, or justifiable in agency terms); this proposal is judged by his peers, primarily on a basis of present or future competence of the man and merit of the problem. But the ward is now made to an institution, acting as a facility and as a bookkeeper.

Besides the fact that institutions would strongly resent award of project support to individuals, on the basis that they would lose control of their faculties and thus that certain disruptions of local government

would ensue, it would seem that a mature individual should be supported at least as freely as a fellow not yet fully matured. The very fact that faculties no longer have much to do with the academic governing of their institutions might be offset by such a free award process, and this process might tend to restore desirable control to faculties.

In the event of a free award process being adopted, it would seem that capable persons of like interests would gather together at various institutions and that, in order to keep them there, the institution would offer a favorable atmosphere for the kind of teaching and research which such persons judge to be most suitable. Slowly the schools would conform to certain acknowledged desirable quanta of curriculums and research. This might be the very process needed to eliminate imbalances, to strengthen faculty control of academic matters, and to restore the universities to their proper mission in society, not in a disruptive sense, but slowly and in a wise and progressive manner. The work of research foundations would gradually be diverted to industrial and government laboratories. University presidents would again become academicians, and the research coordinators would find other spheres of administration.

One could envisage the creation of a junior-investigator type of personal research grant to be awarded for three years, with the restriction that the individual must find a suitable faculty home and that he must teach not less than one-quarter and not more than one-half time. The amount the institution would pay for the time devoted to teaching would increase this stipend. After this, there could be offered a senior-investigator personal research grant, on the same terms and with the same restrictions. This also might be offered for three years, with the option of renewal

depending upon performance and productivity. Finally would come the career-investigator stage. It might be awarded for five-year periods, with the restriction that not more than one-quarter time be spent in teaching. Review of performance and productivity would again be part of the picture. In each case the stipend is augmented by part-salaries for the teaching done.

This system would obviously demand a great deal of sober and wise selection of persons and periodic review of performance, but this is the very place to use the senior men of science. Their time might better be devoted to such judging than to scanning proposals for individual projects.

Although the whole college faculty population could not be supported in this manner, a sufficient number could be so supported as to enrich all faculties and to provide a leavening that would stimulate the teachers and workers who are not so supported or who do not remain in this support cycle all their lives. For those people who are selected to begin such a program or for those who never participate in the program, accessory programs could be developed and administered to stimulate additional young individuals or to furnish small grants for quarter-time and summer-time research support for persons who are primarily teachers. The effect on both teachers and students should be inspiring, and, in due time, it might be hoped that such a system would slowly and painlessly alleviate such problems as now confront the nation—manpower needs, adequate training, betterment of curriculums, increase of basic research, and regeneration of the schools. This program of continued support for superior persons, along with desirable accessory programs, functioning at its optimum would, in effect, be a science policy for the nation.



## Longevity under Adversity in Conifers<sup>1</sup>

Edmund Schulman

Division of Geological Sciences, California Institute of Technology,<sup>2</sup> Pasadena

On marginal sites in semiarid regions of the western United States, trees of several coniferous species have been found that far exceed the generally accepted maximum ages for these species. The annual stem growth of such trees is extremely small (*1*); nevertheless,

the width of the annual rings in many of these trees is particularly sensitive to the varying rainfall from year to year (*2*). This remarkable combination of longevity and sensitivity makes it possible to derive tree-ring indices of past year-by-year rainfall that are more reliable than indices based on the much younger trees found on less arid sites. Field sampling has been largely limited to conifers because, in the areas studied, they live longer than the hardwoods, are far more extensively distributed, and have rings that are easier to date and interpret than the rings in most hardwood species.

During some 15 field seasons, in each of which an intensive search was made for overage coniferous trees, criteria have been recognized that aid in finding

<sup>1</sup> Abstracted and extended from "Tree-Rings and Climatic Changes in Western North America," contract report of June 20, 1953, to the Office of Naval Research. The cooperation of the U.S. Forest and Park Services in all field work is much appreciated. The White Mountain pines were sampled through the courtesy of S. F. Cook and Nello Pace (ONR *Research Reviews*, March, 1952, frontispiece). Support by the American Academy of Arts and Sciences made possible the Patagonian survey of 1949–1950. I am much indebted to Frits W. Went for field aid during September, 1953. Much of this work has been done under the auspices of the University of Arizona, from which the writer is on leave.

<sup>2</sup> Contribution No. 665.

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the oldest ones. The types of sites that had been found to be favorable for sensitive growth reaction to dry or wet years (3), such as steep rocky slopes or ridges, lower forest limits for the species, and open stands, were also found to favor longevity.

Special characteristics of the oldest individual trees seem to be (a) low ratio of height growth to diameter; (b) sparse foliage; (c) relatively smooth and thin bark; (d) gnarled or spiral growth in some species; (e) centuries-long longitudinal retreat of the cambium-edge from the leaders (here called endogenous dieback, for this spike form of the dead leaders should be distinguished from the characteristic branchlet-covered form that results from the rapid killing by pests); and (f) lateral retreat of the cambium-edge in some species, as shown by barkless stem areas or by one or more barkless strips along the branches, down the stem, and along exposed roots.

Although the overage drouth conifers are found on very thin or patchy soils derived from both sedimentary and igneous rocks, the former type, particularly the limestone group, seems to provide a more favorable environment for maximum attainable ages. Whether this is related to specially favorable soil properties or to biotic factors is not known.

The part of the species range in which the tree is located also seems to be closely related to its potential longevity. For each of the extensively sampled species, one or more areas of absolute maximum age have been found; in other areas, the maximum ages tend to be lower with distance from the "high," in a pattern similar to that of the isolines on weather maps.

Numerous living giant trees of many species are said to be at least 3000 yr old (4); these ages are based on estimates of growth in the outer stem, growth in neighbors, size alone, or legend. Most, or possibly all, such trees, except a few standing giant sequoias, are perhaps much overestimated, for it is becoming increasingly clear that almost all very large trees are growing in locally favorable environments and have relatively rapid early growth. Instrumental and other problems have not, in general, permitted bark-to-pith coring of these trees, which, when followed by precise ring dating, is essential to the true age determination. Of the thousands of examined stumps of giant sequoias, only four have yielded verifiable ages in excess of 3000 yr (3, 5). The oldest of these, felled in 1892, was found to have an inner-ring date of 1307 B.C. on the stump sample, to which may be added about 10 yr of center growth decayed away and some 5 yr of height growth to stump-top.

Far shorter than in *Sequoia* is the normal maximum life span in *Pinus*, which for various American species has for decades been considered to lie approximately within the range of 100 to 600 yr (6). Only recently have verifiable maximum ages exceeded this by 2 or 3 centuries (7). If we confine the list of maximum ages to those based on actual ring analysis, no pines are known in Scandinavia above 550 yr (8) or in central Europe above 750 yr (4), as far as the writer is aware.

However, estimates of maximum ages of pine far exceed the limits noted. One, made by Klein in 1899 and fully discussed by Molisch, of about 1100 yr for a Swiss stone pine seems safer than most. In recent years, the high altitude bristlecone pines in the White Mountains of California were recognized by National Forest personnel as likely to reach unusual ages, and a selected stand has recently (November, 1953) become especially protected in a natural area. In the Grand Teton Mountains of Wyoming, Griggs estimated whitebark pine (*P. albicaulis*) to reach 1500 to 2000 yr (9), on the basis of maximum diameters and the observed growth rate in smaller trees.

Although the uncertainty in estimates such as those cited is widely recognized, it appears from work during the last two field seasons that the verifiable maximum ages in certain species of *Pinus* do, in fact, far exceed the long-established limits. The trees of great longevity that have been found recently are all from environments strongly limited with respect to moisture or temperature or both.

It may be noted in Table 1 that the two oldest pine trees presently known are represented, respectively, by 1658 and 1495 yr of growth on the increment cores. Both trees are sound and would appear to have life-expectancies still measurable in centuries. One may also note that (a) the species, limber pine and bristlecone pine, in which the maximum ages have been found have been only spottily sampled, (b) the maximum-age distribution patterns for these species are thus particularly ill-defined, and (c) other long-lived species of pine remain to be studied. Thus, we may conclude that pine trees of certain types can at least slightly exceed 2000 yr in age.

Of physiological interest is the limit to the slowness of annual stem growth in trees such as those reported in Table 1. Since, in poor growth years, this limit may be zero in a selected area of the cambium, even for uninjured fast-growing trees, the total radial growth of a century is here examined. In the several thousand North American drouth conifers now sampled, a total accretion of less than 15 mm is common, 10 mm is very rare, and 8 mm is the minimum anywhere in the lower stem of these trees. The minimum radial growth observed in a branch, in tree 3966 (Table 1), was about 3 mm/century; the interval A.D. 362 to 1018, when local death of the cambium on the measured radius occurred, showed an over-all mean growth rate for the 657 yr of almost exactly 0.04 mm/yr.

Since the average annual radial growth in the lower stem of a mature drouth conifer is of the order of 0.3 mm and the standard deviation in its ring widths is found to be 20 to 40 percent or more, a high incidence of locally omitted annual rings could well make precise dating of the ring sequence impossible. Omission of a ring in any increment core represents, of course, local quiescence in cambial-cell division during the entire growth season of that year. Such omissions seem to be relatively rare in those overage conifers that grow in the central and northern Rocky Mountains and also at elevations above 8000 ft or so in the

TABLE 1. Some growth characteristics of the oldest known drouth conifers.<sup>1</sup>

Tree No. <sup>a</sup>	Sampling date	Species <sup>b</sup>	Sapwood		Inner ring, A.D.	Outer ring, A.D.	Mean ring width (mm)		Radius (mm)	Age (yr)	
			(mm)	(yr)			Over-all century	Min. sample		Total (estim.)	Sample
3996	7/52	LBP	10	53	458	1952	0.27	0.08	402	500	1495
4020	9/53	"			296	1953	0.36	0.18	610	620	1658
3966	7/52 <sup>d</sup>	"	15	75	333	1953	0.25 <sup>e</sup>	0.12 <sup>e</sup>	428	428	1621
4025	9/53	"	20	84	584	1953	0.33	0.20	448	575	1370
4026	9/53	BCP	26	96	535	1953	0.43	0.16	607	750	1419
4038	9/53	"			655-	1953	0.26	0.11	343	400	1299+
4057	10/53	"	15	70	892	1953	0.36	0.15	384	525	1062
2522	5/48	PNN			975	1947	0.43		416	416	973
957	10/41	"			1089	1941	0.27		232	240	853
4002	7/52	PP	23	130+	1110-	1952	0.42	0.14	354	375	843+
3084	6/50	DF	22	79	1080	1950	0.36	0.22	313	340	871
3335	9/50	"	15	78	1084	1950	0.20	0.09	176	185	867
3339	9/50	"	27	78-	1092	1950	0.24	0.16	206	210	859
1456	8/44	BCS	28	125	1385	1944	0.50	0.23	278	325	625
2983	1/50	AL	23	175+	713-	1949	0.30	0.12	366	750	1237+
3018	2/50	"	12	170+	652-	1949	0.25	0.05 <sup>f</sup>	320	550	1298+
3773	7/51	SCJ	12	82+	928-	1951	0.38 <sup>g</sup>	0.16	385	760	1024+
3562	6/51	WJ	46	205+	896-	1950	0.31	0.20	320	575	1055+
											1300 <sup>h</sup>

<sup>1</sup> *Fitzroya cupressoides* (trees 2983 and 3018), a wet-climate species, is an exception, listed here for comparative purposes. The rings in the two alerce and the two junipers at the end of the table were not datable. Data for tree 4038 represent the central stem of "The Patriarch," 37.7 ft in circumference, which was discovered by Ranger Alvin E. Noren.

<sup>a</sup> Location:

3996	43° 46' N	114° 16' W	6500 ft	Sun Valley Area, Idaho
4020	.37 32	118 08	10500	White Mountains, Calif.
3966				See 3996
4025-26				See 4020
4038	37 32	118 11	11300	White Mountains, Calif.
4067	37 25	118 10	10200	White Mountains, Calif.
2522	38 37	110 22	7200	N of Sunnyside, Utah
957	37 35	108 33	7500	N of Dolores, Colo.
4002	37 39	112 05	7000	Bryce Canyon Natl. Park, Utah
3084	39 48	110 20	7200	NE of Price, Utah
3335	39 37	106 51	6700	W of Eagle, Colo.
3339				See 3335
1456	33 48	116 44	4700	S of Idyllwild, Calif.
2983	42 34' S	71 53	4500+	Lago Claro, Argentina
3018	41 50' S	72 35	4500	Hornopirén Peninsula, Chile
3773	41 50' N	111 38	8500	NE of Logan, Utah
3562	37 57	119 18	8300	W of Leevington, Calif.

<sup>b</sup> AL Alerce, *Fitzroya cupressoides*  
BCP Briarcone pine, *Pinus aristata*  
BCS Bigcone-spruce, *Pseudotsuga macrocarpa*  
DF Rocky Mountain Douglas-fir, *Pseudotsuga menziesii* var. *glauca*  
LBP Limber pine, *Pinus flexilis*  
PNN Pinyon pine, *Pinus edulis*  
PP Ponderosa pine, *Pinus ponderosa*  
SCJ Rocky Mountain juniper, *Juniperus scopulorum*  
WJ Western juniper, *Juniperus occidentalis*

<sup>c</sup> A minimum number of years were added to those on the sample, on the basis of early growth rate, estimated length of untrapped radius, and estimated sapling age at sampling level.

<sup>d</sup> Tree cut Sept. 18, 1968; entry represents the 1952 increment core, with inner ring at A.D. 563.

<sup>e</sup> East radius; west radius, 1210 rings in 348 mm; south radius, 1094 rings in 251 mm.

<sup>f</sup> Outer 130 rings in 6.0 mm; outer 800 rings in 99 mm; inner 50 rings in 45 mm.

<sup>g</sup> Inner two centuries on core 0.66 mm; inner 50 yr, 0.90 mm; this is the Old Utah or Jardine Juniper (ref. 4, Fig. 7).

<sup>h</sup> Several weathered western juniper trees north of Tenaya Lake, Yosemite Natl. Park, yielded ring counts on eroded stem surfaces which seem to place them in the 2000-yr class, but no successful boring of these trees has yet been made.

Southwest. This is fortunate, for it is in such areas that the very oldest trees in the sampled species were found. The low frequency of locally omitted rings seems to be characteristic of growth in the upper, as well as the lower, stem and also in the branches and roots of such trees. False, or nonannual, rings are rarely found and, when present, are easily recognized in overage conifers.

Even at 10,000-ft elevation or as far north as lat. 51°, however, it was found that, in a small fraction

of the increment cores from overage trees, as many as five or more rings were omitted per century. The recognition of such omissions and, hence, the precise dating of the entire sequence of rings on such a core were possible for certain stands of trees—those in which the amount of ring growth from year to year was found to fluctuate more or less synchronously in the various trees, so that detailed cross comparisons in chronology could be made.

Although this discussion is primarily concerned with

trees in arid or arid-alpine areas, certain features in the growth of *Fitzroya cupressoides* (alerce), a South American wet-climate tree, are of relevance here and data are included in Table 1. The ring numbers in these trees represent counts only, since no consistent chronology was present in the succession of ring widths in the older trees that would permit cross check with neighboring trees. Thus, omission of rings, which in the very crowded and highly variable ring sequences in these trees may amount to several percent, cannot be recognized. However, the annual nature of the ring has been verified. Although, in many properties, trees of this species bear some astonishing resemblances to *Sequoia*, they appear able to reach much lower growth rates. The record low accretion of some 4.6 mm in radial stem growth per century, measured in the outer 130+ rings of tree 3018 (Table 1), is the more remarkable in that it was laid down as normal growth in a tree of good crown and entire bark, at about 4500-ft elevation in a cold-climate mountain jungle enjoying a mean rainfall of approximately 200 in./yr. However, the maximum stem diameter in *Fitzroya* does not approach that in *Sequoia*; the largest alerce observed, the "Silla del Presidente" (10), near Puerto Montt in southern Chile, had a diameter of 120 in. inside the bark and above the basal flares. Growth on the stump, a characteristic shell only, suggests an age of the order of 2000 yr. On the basis of only a minor sample of the small existing range, the two trees listed in Table 1 were the oldest standing ones found in Argentina and Chile, respectively; all the old sampled trees of this species showed center rot, usually advanced.

To what may we ascribe the great longevity under adversity of trees such as those here reported? Observed in the field were the well-recognized causes for the death of trees: (a) gross destruction by man, fire, insects, wind, erosion and imbalance, lightning, flooding, and the like; and (b) more subtle destruction in parasitic attack, especially that causing rot, and insufferable climatic years with resulting starvation or fatally weakened resistance to disease. Do trees become senile, with death as the end stage? This is a possibility many plant physiologists reject, according to Molisch (4); he presents some evidence in its favor. Is the increased resistance to water transport with growth in size (11) a factor of reduced importance in the characteristically stunted trees here reported? The following observations would seem to be relevant to these questions.

1. The areas of maximum ages for each species have maximum numbers of hardy, overage trees.
2. Extremely slow-growing overage trees of some coniferous species tend, in general, to be relatively free of center rot at ages that are associated with much rotteness in fast-growing, favorably situated trees of the same species. (Is center rot a form of dieback?)
3. Open stands, rocky sites, stunted size, and sparse

vegetation seem to inhibit the direct agents of destruction.

4. Some individual resinous conifers, having suffered severe mechanical injury, were stimulated to excess resin production and, thus, perhaps fought off the agents of decay.

5. In *Pseudotsuga menziesii* and in the extensively sampled species of *Pinus*, longitudinal retreat of the cambium-edge has been observed in an essentially complete range, the endogenous dieback in 400 to 500-yr trees at tips only culminating (in trees centuries older) in but one or two remaining living branchlets. In some localities numerous dead snags testify to the end-result.

6. Laterally retreating cambium-edge has been observed, in some species, to reach the stage in the oldest trees of a single vertical or spiraling thin strip of bark-covered living tissue, the trees still showing little or no sign of center rot. In the analyzed species, lateral retreat seems to be possible only in the presence of longitudinal retreat; however, the latter may exist with no visible sign of the former, as in *Sequoia gigantea*.

Perhaps the most intriguing of the unanswered questions regarding longevity in conifers has to do with *Sequoia gigantea* trees, which, some believe, may enjoy perpetual life in the absence of gross destruction, since they appear immune to pest attack. However, if we may reason by analogy in this case, the endogenous dieback of the main stem, which is observable in all old trees of this species, and the relentless progress of this phenomenon with advancing age in other species do not support this belief. Pertinent also is the well-known fact that standing snags of this species, other than those resulting from factors of gross destruction, are unknown. Does this mean that shortly preceding 3275 yr ago (or 4000 yr ago, if John Muir's [12] somewhat doubtful count was correct) all the then living giant sequoias were wiped out by some catastrophe? Does the probability of any individual *Sequoia* surviving all the forces of gross destruction for much more than 3000 yr become vanishingly small?

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## News and Notes

### Third International Conference on Low Temperature Physics and Chemistry

THE Rice Institute was host to 250 leading physicists and chemists concerned with the properties of matter at very low temperatures. The conference, held in Houston, Tex., Dec. 17-22, 1953, was sponsored by the Institute, the National Science Foundation, and the International Union of Pure and Applied Physics. More than 100 papers were presented and the sessions covered a wide range of studies at liquid helium temperatures. The delegates were from the leading laboratories in Australia, Belgium, Canada, France, Germany, Great Britain, The Netherlands, and the United States. C. J. Gorter of Leiden University represented the International Union. The conference permitted ample time for informal discussions by groups of from two to ten people, who thus were able to work out differences of opinion and clear up experimental problems.

It is no surprise that the properties of liquid helium isotope three received attention and that the new theory on superfluid liquid helium by R. P. Feynman of California Institute of Technology was much discussed. Steady progress has been made on the magnetic properties of matter at low temperatures, and a new magnetic cycle refrigerator capable of maintaining a constant temperature of  $0.2^{\circ}$  K was described by C. Heer and J. Daunt of Ohio State University. We shall mention here only a few of the papers that stimulated unusual interest. Space does not allow us to report many other valuable contributions.

Prof. Pippard described experiments on the residual flux trapped in superconducting tin-indium alloys. The experiments consist of measuring the flux frozen in a tin-indium cylinder after the superconducting transition has been effected by removing a transverse magnetic field. For tin with less than 1.8 percent indium, it is found that the percentage of flux trapped (defined as  $8 \pi M/H_c$ , where  $M$  is the magnetic moment of the rod and  $H_c$  is the critical field for the temperature at which the transition is made) is constant at low temperatures and decreases near the critical temperature. For 2-percent indium content, the behavior is quite different. The percentage of flux frozen in is constant at low temperatures, but increases very sharply near the critical temperature. These results are taken as evidence that the indium impurity can lower the interphase surface energy between normal and superconducting regions, although criticism was raised concerning the solubility of indium in tin.

Dr. Faber reported on a continuation of his supercooling experiments. Due to the large difference in the critical temperatures of tin and aluminum, a large difference in the characteristic length (defined as  $8 \pi a/H_c^2$ , where  $a$  is the interphase surface free energy per unit area) is expected. This result is confirmed. It is proposed that a measurement of the penetration

depth in aluminum will serve as a critical test between the predictions of the Ginzburg-Landau theory and the predictions of Pippard.

Dolocok reported a new and possibly more accurate method of determining the latent heat of transition from the super to the normal state of metals. He measured the magnetic field that will make this transition isothermal, and calculated the latent heat from the induced eddy currents.

Results of high-pressure research at low temperatures were presented by several investigators. C. A. Swenson of MIT described an apparatus capable of producing 10,000 atm pressure with which he is studying Young's modulus of selected materials at temperatures of from  $300^{\circ}$  to  $4^{\circ}$  K. In compressing solid hydrogen at  $4^{\circ}$  K, he found that at approximately 2000 atm the hydrogen escapes from the cylinder. As the gap between piston and cylinder is very small, this might mean that hydrogen melts at this pressure and temperature. M. D. Fiske of General Electric reported an ingenious "hot wire" technique by which he is able to obtain hydrostatic pressures with solid helium. G. O. Jones of Queen Mary College, University of London, presented his recent investigations of the effects of pressures up to 40,000 atm (obtained at the apex of a double cone clamped tightly before cooling) on the phenomenon of superconductivity. Jones found that this extreme pressure reduces the temperature at which tin, lead, and thallium become superconducting. For tin and lead the results are in accord with previous work at much lower pressures; but in the case of thallium, Jones' results are opposite in sign and thus contradict early low-pressure work and recent high-pressure work by Fiske, who used the same technique as Jones. An interesting result of Jones' work is that he has caused bismuth, which at extremely low temperatures has remained a normal conductor, to become superconducting at  $7^{\circ}$  K under 40,000 atm. Bridgman has shown that for pressures above 20,000 atm, bismuth converts to other modifications and so, as in the case of tin, one of the modifications of bismuth becomes superconductive.

There were a number of interesting papers on magnetism at low temperatures. Dr. Kurti reported the work on nuclear alignment done at Oxford, while Dr. Steenland discussed that at Leiden University. Various properties of nuclei have been determined, in particular the spin assignment of the various levels, the multipole character and parity changes of the transitions and, finally, the nuclear magnetic moment of the radioactive nucleus. The measurements consisted of the determination of the polar diagram of the gamma-ray emission and of the directions of the polarization of the gamma-rays. The work at Oak Ridge National Laboratory under L. D. Roberts and S. Bernstein showed the results on nuclear polarization of manganese salts as well as studies with Sm<sup>149</sup> nuclei.

Several aspects of paramagnetic salts at extreme

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low temperatures were discussed. Cooke reported the use of anisotropic susceptibilities, and Hudson and Steenland compared potassium chrome alum with chromic methylamine alum. Steenland concluded that at the lowest temperatures this chromium methyl amine alum behaves like an antiferromagnetic substance.

An interesting session on magnet design and techniques was led by D. de Klerk of Leiden University. Also, the paper by J. Goldman of Carnegie Institute of Technology on ferromagnetic and antiferromagnetic interactions at low temperatures should be mentioned.

The theory of liquid helium was a subject of considerable discussion. R. P. Feynman presented a paper on the nature of the elementary excitations in the liquid. At very low temperatures, near the absolute zero, the excitations consist of phonons, as has already been suggested by Landau. At temperatures above 0.6° K, other excitations are important. These excitations are similar to the "rotons" proposed by Landau and consist of the rotational motion of small groups of atoms. The Bose-Einstein character of He<sup>4</sup> is important to the existence of these excitations. Approaching the condensation from the high-temperature side, one finds a somewhat different picture. R. P. Feynman ascribes the lambda transition to the Bose-Einstein condensation, but has described the properties below the lambda temperature only in terms of the excitations mentioned above. These two separate points of view have not so far been reconciled.

H. N. V. Temperley also reported work on the theory of helium three and four. A theory which has since been published in the *Proceedings of the Physical Society, A*, described the structure of He<sup>4</sup> in terms of small aggregates of atoms, an interpretation somewhat similar to that presented by Feynman. The theory has the advantage that both helium transitions can be treated in one model. Dr. Temperley also described how the introduction of Van der Waals forces in an ideal Fermi gas could explain roughly the melting and evaporation of helium three.

The hydrodynamics of He<sup>4</sup> were given in a paper by P. Zilsel of the University of Connecticut. This paper was read by F. London. Prof. Zilsel indicated how the two-fluid model for liquid helium could be justified on the basis of the Bose-Einstein condensation.

Several experiments of fundamental importance to the theory of helium three were reported. Vapor pressure measurements down to 0.47° K, reported by S. G. Sydoriak and T. R. Roberts of Los Alamos Scientific Laboratory, are in agreement with the calculations of Chen and London, who have predicted that there is no excess of entropy at higher temperatures. These measurements indicate that there is no transition in He<sup>3</sup> at some lower temperature similar to the lambda transformation in He<sup>4</sup>. The measurements of G. deVries and J. G. Daunt of Ohio State University and of Osborne, Abraham, and Weinstock of Argonne National Laboratory on the specific heat of He<sup>3</sup> also indicate

that there is no excess entropy at the temperatures investigated. Further, these measurements seem to show that the specific heat of He<sup>3</sup> is not linear with temperature, as would be expected for an ideal Fermi gas. However, all these experiments indicate that at around 0.5° K, nuclear alignment will set in, since they show that at just under this temperature the entropy of the liquid drops below  $R \ln 2$ . This is the entropy of randomly distributed nuclear spins, and as the spins are presumably unoriented in the solid, this implies that the entropy in the solid will be greater than that of the liquid below this temperature. The melting curve would therefore have a negative slope, and Osborne *et al.* had previously pointed out that this disagreed with their measurements. They now withdraw this criticism because the capillary will always block at the minimum of the melting line if that minimum occurs at a higher temperature than is being measured. The nuclear susceptibility measurements of W. Fairbank, W. Ard, H. Dehmelt, and W. Gordy of Duke University also show that He<sup>3</sup> does not behave as an ideal Fermi gas down to 1° K, since the susceptibility does not become independent of the temperature as would be expected, but is still proportional to the reciprocal of the temperature. Drs. Guttmann and Arnold of the University of Chicago reported experiments demonstrating the nonparticipation of He<sup>4</sup> in the superfluidity of He<sup>4</sup>. They pointed out that several interpretations are possible.

A number of other experiments on the properties of helium four were described. Measurements at the National Bureau of Standards by J. R. Pellam and W. Hanson on the attenuation of second sound, and similar measurements by K. Atkins at Toronto, indicate that the normal thermal conductivity as well as the viscosity must be taken into account, as predicted by Khvelatnikov. Measurements on the helium film reported by K. Mendelssohn and by L. C. Jackson indicate that the mechanism of the formation of the film is still not well understood. The thickness of the film seems to depend on the method of measurement, and the relation of the thick, saturated film to the unsaturated film is still something of a mystery.

Neutron diffraction by liquid helium was discussed by H. London and also by Dash, Sommers, and Goldstein.

Meissner reported the results of measurements of the viscosity of He<sup>3</sup> and He<sup>4</sup> gas and showed them to be in agreement with calculations of de Boer using Fermi-Dirac and Bose-Einstein statistics.

G. Hercus and J. Wilks of Oxford reported measurements of the specific heat of helium that are approximately 10 percent higher than those found by previous workers. Their results seem to be in accord with some of the thermodynamic data that are already available.

It was surprising to note the excellent agreement between the measured specific heat of copper and that calculated from the elastic constants measured at these low temperatures by Overton.

Measurements of the susceptibility of a paramagnetic salt between 1.2° and 4.2° by R. Erickson and

L. Roberts of the University of Tennessee and Oak Ridge National Laboratory indicate that the present vapor-pressure temperature scale for helium four may be in error by as much as 0.012° at the lambda point, in agreement with the results of Kistemaker. These conclusions are confirmed by comparison with other thermodynamic data.

C. F. SQUIRE  
and the staff of  
The Rice Institute

Houston, Texas

## Science News

The following paragraphs on the trial establishment of special committees to advise local draft boards on scientific personnel appeared in the March issue of *Selective Service*, the official bulletin of the Selective Service System.

Maj. Gen. Lewis B. Hershey, Director of Selective Service, has requested the State Directors of six selected States to establish advisory committees to provide means whereby the System may be provided with reliable information on scientific, engineering, and other specialized personnel.

When General Hershey sent the directive to the six selected States he . . . explained that the program was being set up on a trial basis for the purpose of testing the practical usefulness of such a program throughout the System.

In view of the increasing technical nature of many occupations, it was felt by the Director of Selective Service and the Director, Office of Defense Mobilization, that some effort should be made to set up some type of system whereby local boards could be provided, in appropriate cases, with expert advice. . . . The States selected to try the program out are: Alabama, California, Michigan, New Jersey, New York, and Ohio. . . . The only direction General Hershey gave the State Directors in setting up the committees was the strong reminder that the functions of the committees will be *advisory* only.

An improved purification method, useful for the controlled blend of pure germanium with traces of other specific elements essential for transistor construction, has been invented by W. G. Pfann of Bell Telephone Laboratories. As an ingot of germanium passes through a hoop of induction-heating wire in this process, a narrow band of the germanium melts and its impurities are dissolved in the liquid zone as it moves the length of the metal bar. Only one part in ten billion of anything but germanium remains, while other material becomes concentrated at the end of the bar. This end is then sawed off, leaving the pure germanium ready for final reworking into transistor material.

An improved machine for sorting physical objects into a large number of categories has recently been developed by Jacob Rabinow of the National Bureau of Standards. Designed at the request of the Bureau of Census, the device was built to sort punched cards

at the rate of 420 per minute. The principle is also applicable to sorting such other objects as mail, electrical and mechanical components, and farm produce, as well as checks, invoices, and other papers. All items that can be separated into a number of subdivisions can be handled by an electromechanical system similar to the NBS sorter.

The machine developed at the Bureau consists of five major components: (1) a sensing unit that reads the data-bearing cards and decides where they should go; (2) an addressing device that loads the conveyor with the cards and their corresponding address numbers; (3) a conveyor belt that carries both the card and its address number; (4) a series of recognition devices, actuated by the information-bearing mechanism of the conveyor belt, which operate trip mechanisms so that the cards are released from the conveyor; and (5) a series of receptacles, or gates to other devices, into which the material borne by the conveyor is sorted.

Four Harvard University botanists—Paul C. Mangelsdorf, Elsa S. Barghoorn, Walton C. Galinat, and Margaret Wolfe (Radcliffe College)—have announced new evidence concerning the origin of corn. Their conclusions:

1. Corn is definitely a native of this hemisphere and did not originate in Asia; its North American history goes back at least 60,000 years.

2. Corn is not a descendant of a Mexican grass called "teosinte," though the latter did play a part in the development of modern corn through natural hybridization processes; teosinte is corn's closest relative and a contributor to its recent evolution.

Evidence for corn's North American origin was obtained in the summer of 1953 with the finding of fossilized grains of corn pollen at a depth of more than 200 ft beneath Mexico City. The pollen fossils were discovered in drill cores studied by Paul Sears of Yale University and Kathryn Clish of Oberlin College. The pollen grains were first thought to be those of teosinte. Definite determination that they were not teosinte, but corn, was made by Dr. Barghoorn and Miss Wolfe, who have developed new laboratory techniques for distinguishing the pollen of corn from that of other grasses such as teosinte.

It was also reported that synthetic hybrid corn cobs, produced through the laboratory mating of modern corn and teosinte, closely matched in size and botanical characteristics prehistoric cobs found in caves in the southeastern United States. The research group's findings were obtained by pooling discoveries and observations with those of climatologists and archaeologists from many other colleges and museums. Among the latter was the National Museum of Canada, the Colorado State Museum, and the National Park Service.

South America's first cyclotron, built at the University of Chicago, is en route to Rio de Janeiro. One of the smallest in terms of physical size, the entire device is about 5 ft long by 2 ft wide, stands 3½ ft

high, and weighs 11 tons. Design and construction were supervised by Herbert L. Anderson, professor of physics in the University's Institute for Nuclear Studies, and Lester Kornblith, Jr. Working with them was Mario Donato Amoroso Anastacio, assistant professor in the Brazilian Center for Physical Research, who spent a year and a half at the university.

Funds for the project, some \$85,000, were provided by the Brazilian government through its National Research Council. The U.S. Office of Naval Research co-operated in the venture by supplying the salaries of the American staff during the design and construction.

The value of the polio vaccine to be given a mass trial this year will be determined in a study directed by Thomas Francis, Jr., chairman of the department of epidemiology in the University of Michigan School of Public Health. The work will be financed by a grant from the National Foundation for Infantile Paralysis, which is sponsoring the trials of the vaccine, but it has been made clear that the project will be completely independent. An evaluation center will be established at the University of Michigan and the university's survey research center will assist in collecting data and preparing statistical analyses.

## Scientists in the News

**Edward L. Cochrane**, dean of the School of Engineering at the Massachusetts Institute of Technology, has been appointed vice president for industrial and governmental relations, effective Apr. 1. He will be succeeded as dean by **Richard Soderberg**, head of the Department of Mechanical Engineering at MIT since 1947. In his new post, Prof. Cochrane will be concerned with the whole range of the Institute's responsibilities to industry and government.

**Robert N. Cooley** of the Department of Radiology, Johns Hopkins School of Medicine, has accepted appointment as professor of radiology and chairman of the department at the University of Texas Medical Branch. A considerable extension of department facilities in the new John Sealy Hospital building is being developed under Dr. Cooley's direction.

**Arthur Paul Dowling**, former technical director at the Rock Island Millwork Company, has been appointed a full research plastics chemist at the Armour Research Foundation of the Illinois Institute of Technology.

On Mar. 14, the 75th birthday of Albert Einstein, a selection committee at the Institute for Advanced Study announced that the Einstein Award would be given this year to **Richard Phillips Feynman** of the California Institute of Technology. This award, established in 1950 by the Lewis and Ross Strauss Memorial Fund, consists of a gold medal and \$15,000. Previous medalists have been Julian S. Schwinger of Harvard University and Kurt Gödel of the Institute for Advanced Study.

**Dr. Feynman**, a graduate of the Massachusetts Institute of Technology, received his Ph.D. degree from Princeton University in 1952. He was professor of physics at Cornell University from 1945 to 1948. The main area of his research is quantum mechanics and, particularly, quantum electrodynamics. He has contributed to the development of some of the most important results and concepts of the decade. His treatment of quantum mechanics by the probability amplitude method, and the establishment of what is known as the Feynman diagram to account for possible particle transformations, are especially noteworthy.

**Lynn L. Gee**, a professor of bacteriology at Texas Agricultural and Mechanical College from 1948 to 1954, has been appointed professor of bacteriology and head of the department at Oklahoma Agricultural and Mechanical College.

In the Department of Bacteriology at the University of Nebraska, **Carl E. Georgi** has succeeded G. W. Pelletier as chairman of the Department, and **Warren Engelhard**, formerly of Ohio State University, is teaching pathogenic bacteriology and immunology.

The University of Tübingen has conferred the honorary degree of Doctor of Natural Science on **Ross G. Harrison**, Sterling professor of biology emeritus, Yale University.

**James Hodge**, a leading British authority on gas turbines and jet engines, has been appointed visiting lecturer in Columbia University's Mechanical Engineering Department for the spring semester. He will give two graduate courses in the evenings. Mr. Hodge is senior consultant engineer of Power Jets, Ltd. and is also associated with the School of Gas Turbine Technology at Farnborough, Eng., where the first jet aircraft engine was developed by Sir Frank Whittle.

**Albert H. Holland, Jr.**, since 1951 medical director of the Armour Laboratories, Chicago, has been appointed director of the Division of Medicine, Food and Drug Administration, U.S. Department of Health, Education, and Welfare. The post has been vacant since 1952 when Erwin E. Nelson resigned to head the Department of Pharmacology at the St. Louis University College of Medicine.

The Washington (D.C.) Academy of Sciences has announced that the following three men are winners of annual recognition awards.

**Bernard L. Horecker**, chief of the enzyme research group at the National Institutes of Health, for his research in enzymology. He found a new enzyme—pentose phosphate isomerase—and demonstrated the fixation of carbon dioxide, thus providing a new pathway of carbon dioxide assimilation. This led to his discovery of two hitherto unknown enzymes that catalyze the transformation of sugars.

**Robert L. Henry** of the Electronics Division of the National Bureau of Standards, for his technical direction of the large-scale engineering development proj-

ect known as "Project Tinkertoy." By his ingenuity and by his prolific invention of novel methods he has been responsible for basically unusual systems of design and construction of electronic equipment. Dr. Henry's techniques have made it possible to manufacture intricate apparatus by mechanical means rather than by hand-assembly methods.

**John R. Pellam**, chief of the Cryogenics Physics Section at the National Bureau of Standards, for his many contributions in the field of low temperature physics. He has made two discoveries of importance for the development of the theory of liquid helium II: first, that the velocity of second sound in liquid helium II below 1° K does not approach zero at the absolute zero, but instead increases with decreasing temperature; second, that the thermal Rayleigh disk can be used to demonstrate and investigate the flow of normal and superfluid liquid helium past each other. These difficult experiments resolved an international controversy between theoretical predictions that were diametrically opposed.

On July 1, **E. Hugh Luckey** will assume the position of dean of the Cornell University Medical College in New York City. He has been affiliated with the College since 1944 and has directed the Cornell Medical Division of the Bellevue Hospital Center since 1950. Cornell Medical College is joined with the New York Hospital to form the New York Hospital-Cornell Medical Center. Dr. Luckey succeeds **Joseph C. Hinsey**, who became director of the Medical Center last July after 11 years in the deanship.

**C. J. Mackenzie**, member and past president of the National Research Council of Canada, has received the Kelvin Gold Medal for 1953. This medal, established in 1914 as a memorial to Lord Kelvin, is awarded triennially by the presidents of the principal engineering institutions in Great Britain on recommendations received from engineering societies in all parts of the world. Dr. Mackenzie is the first Canadian in a list of winners that includes Marconi and Whittle.

**Donald H. Menzel**, professor of astronomy at Harvard University and associate director for solar research, has been appointed director of the Harvard College Observatory. He succeeds Harlow Shapley, who retired in the summer of 1952.

Facilities that fall under Dr. Menzel's supervision include the Cambridge Observatory; the George R. Agassiz Station at Harvard, Mass.; the High Altitude Observatory which operates in cooperation with the University of Colorado at Climax, Colo.; the Upper Air Research Station at Sacramento Peak, Sunspot, N.M.; and a pair of stations for observation of meteors near Las Cruces, N.M. Since 1926 the Harvard Observatory has also operated the Boyden Station in South Africa, but it is expected that this station will shortly be transferred to other management.

**Edwards Albert Park**, at present in the Department of Pathology at The Johns Hopkins University and

for 19 yr head of the Department of Pediatrics, has been awarded the New York Academy of Medicine Medal. He was cited for being "one of the true leaders in science of our times." Dr. Park is an authority on bone diseases.

**George T. Perkins**, has been assigned to Walter Reed Army Medical Center, Washington, D.C., as director of the Dental Division, Army Medical Service Graduate School. Since 1950 Colonel Perkins has been dental surgeon at Percy Jones Army Hospital, Battle Creek, Mich.

In February, Hans Pettersson of the University of California's Scripps Institution of Oceanography, presented the Albatross Medal of the Swedish Royal Society of Science and Letters to **Roger Revelle**, director of the Scripps Institution, for "his outstanding achievements in oceanography and especially in deep-sea research." The medal commemorates the Swedish deep-sea expedition of 1947-48 that Prof. Pettersson led.

In January **Stephen Rothman**, professor and head of the Section of Dermatology and Syphilology, School of Medicine, University of Chicago, gave the Sigmund Pollitzer Lecture at New York University—Post-Graduate Medical School.

The Société Nationale d'Acclimatation de France has granted the Isidore-Geoffroy-St-Hilaire Medal for 1952 to **Jacques Rousseau**, director of the Montreal Botanical Garden, in recognition of "his activity for the protection of nature."

**Howard A. Rusk**, professor and chairman of the Department of Physical Medicine and Rehabilitation of New York University's College of Medicine and director of the Institute of Physical Medicine and Rehabilitation of the New York University-Bellevue Medical Center, has received the Save the Children Federation's fourth annual award "in recognition of distinguished and devoted service in the field of health and welfare for children."

The first Distinguished Service Award of Alpha Epsilon Delta, the national premedical honor society, has been presented to **Aura E. Severinghaus**, associate dean of the Faculty of Medicine, Columbia University, for his outstanding contributions to premedical education. Dr. Severinghaus has been a strong and constant advocate of a broad foundation of liberal preprofessional education for medical students. He served as chairman of the committee which has just completed the survey of preprofessional education that has been published under the title "Preparation for Medical Education in the Liberal Arts College."

The Wenner-Gren Foundation for Anthropological Research has awarded the 1953 Viking Fund awards, consisting of a gold medal and \$1000, to the following three men:

**T. Dale Stewart**, curator of physical anthropology in the U.S. National Museum, Smithsonian Institution,

for achievement in the field of physical anthropology. **Melville J. Herskovits** of Northwestern University, for his work in general anthropology.

**Gordon R. Willey**, formerly with the Smithsonian Institution but now professor of anthropology at Harvard University, for his accomplishments in archeology.

**Carl O. Tongberg**, formerly director of the Research Division of the Standard Oil Development Company's Esso Research Center, Linden, N.J., has been appointed to the post of coordinator of research and development on products. He will be responsible for the Company's world-wide activities in research and development of petroleum products.

The 1953 Research Corporation's \$2500 prize has been presented to two Dutch physicists for work they did 28 yr ago. **George E. Uhlenbeck**, professor of physics at the University of Michigan, and **Samuel A. Goudsmit**, chairman of the Physics Department of the Brookhaven National Laboratory, joined forces as graduate students at the University of Leiden in 1925. There they worked out the theory that electrons spin in their orbits around the nucleus of the atom, a theory that has been cited as "a cornerstone of present atomic theory."

## Education

The amphitheatre at the Louisville General Hospital has been completely renovated and its seating capacity has been increased to 400. It has been named the Fred W. Rankin Amphitheatre in honor of Dr. Rankin, who has been on the surgical staff of the University of Louisville for over 30 yr and professor of surgery since 1941.

The Council on Dental Education of the American Dental Association has announced approval of dental internship or residency programs in 14 additional hospitals. Graduate training programs for dentists have now been approved in 131 hospitals throughout the nation. The programs considered by the Council, which is the dental profession's accrediting agency, include training in such fields as oral surgery, radiology, restorative dentistry, periodontia (treatment of diseases of the gums), anesthesia, children's dentistry, and root canal therapy.

Harvard University has announced the establishment at the Harvard School of Public Health of the **Charles F. Wilinsky Lecture Fund** in honor of the retired executive director of the Beth Israel Hospital and former Deputy Health Commissioner of the City of Boston. Given by Dr. Wilinsky's children and grandchildren, the fund will be used to bring to the School the nation's leading hospital administrators to discuss the role of the hospital in public health.

Dr. Wilinsky has been invited to give the first Wilinsky Lecture; he will discuss "The relation of hospitals and health departments in tomorrow's world" on Apr. 28.

A joint training program for medical technologists has been arranged between the Memorial Hospital at Easton, Md., Inc., and Washington College, Chestertown. The cooperative educational program was made possible by the recent approval, by the Council on Medical Education and Hospitals, of a School of Medical Technology at the Memorial Hospital to be conducted under the direction of E. C. H. Schmidt, pathologist. The plan will permit students who have completed 3 yr of study at Washington College and fulfilled all general requirements for graduation, to transfer to Memorial Hospital for a 1-yr course of professional study in medical technology. Upon successful completion of the course at Easton, they will receive the baccalaureate degree at Washington College and will qualify for examination for registry with the American Society of Clinical Pathologists.

Ernest H. Huntress, director of the Massachusetts Institute of Technology Summer Session, has announced plans for 34 special programs, a series of professional conferences and symposia, and more than 100 courses to be given during the coming summer.

Boston College has announced a special two-week intensive course in modern industrial spectroscopy at Chestnut Hill, Boston, July 12-23. The course is particularly designed for chemists and physicists from industries in the process of installing spectrographic equipment. Information can be obtained from Prof. James J. Devlin, Physics Department, Boston College, Chestnut Hill 67, Boston, Mass.

The Prather Lectures of Harvard University will be given jointly by A. J. Kluyver of the University of Delft, Holland, and C. B. van Niel of Stanford University on Apr. 21-23, and 28-30. The general subject will be "The microbe's contribution to biology."

Indiana University's program to improve high school chemistry education through advanced training for teachers will be supported by the Standard Oil Foundation, Inc., of Chicago. Under the trial plan, the university has accepted a \$1000 grant. It will supply fellowships for five high school teachers taking summer studies towards masters' degrees in teaching with a major in chemistry. Fellowship winners will be chosen by the university from Indiana teachers. Because the university will waive tuition and fees, the Foundation's contribution will be used for expenses of the fellows.

The experiment is an effort to help solve the shortage of qualified chemists. Many scientists blame the shortage on a lack of high school graduates with interest in or basic knowledge of chemistry; this, in turn, is caused by a dearth of adequately-trained science teachers.

Ragnar Granit, director of the Medicinska Nobel-institutet, Neurofysiologiska Avdelningen in Stockholm, is to give the eight Silliman Lectures for 1954 at Yale University between Apr. 29 and May 7 under the general title, "Receptors and sensory perception."

The Lectures will be open to all those interested in neurophysiology, psychology, psychiatry, and related fields. This Silliman series will mark the 50th anniversary of those on "The Integrative Action of the Nervous System," given in the spring of 1940 by Sir Charles Sherrington.

In addition to three basic isotope techniques courses, three special courses will be included in the summer program of the Special Training Division of the Oak Ridge Institute of Nuclear Studies. A new offering of the Division is a 2-wk course in radioactivity designed for teachers in secondary schools and teachers colleges. This course, which begins on June 7, will consist of background lectures in physics and radioactivity, together with a demonstration of all experiments outlined in the recent Atomic Energy Commission booklet, "Laboratory Experiments with Radioisotopes." Emphasis throughout the course will be on the technique of using radioisotopes in classroom demonstrations and in laboratory work. As many as 60 individuals will be accepted for the course.

The Division will open a 1-wk advanced course in Applied Instrumentation beginning on June 28. This course will consist of a group of lectures on instrumentation techniques and demonstrations of modern instruments by technical representatives of the manufacturers. Each manufacturer will be asked to supply instruments and demonstrate techniques involved in a variety of radioisotope problems.

An advanced course in radioisotope applications in biochemistry will be held from Sept. 6 to 17. This is the second such course to be given by the Division. Application blanks and additional information on the courses may be obtained from the Special Training Division, Oak Ridge Institute of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn.

Charles M. Pomerat, director of the Tissue Culture Laboratory of the University of Texas Medical Branch, Galveston, will be director of a special course in tissue culture technique to be offered under the auspices of the Tissue Culture Association in Coopers-town, N.Y., during July.

### Grants, Fellowships, and Awards

The Vincent Memorial Hospital, the Gynecologic Service of the Massachusetts General Hospital, announces an American Cancer Society Fellowship in cancer research. Appointment is for 1 yr, beginning July 1. Further information can be obtained from Dr. Joe V. Meigs, Vincent Memorial Hospital, Fruit Street, Boston 14.

Announcement has been made of the 1955-56 awards under the Fulbright Act for university lecturing or advanced research in Australia, Burma, Ceylon, India, New Zealand, the Philippines, Thailand, and the Union of South Africa. Information may be obtained from the Conference Board of Associated Research Councils, Committee on International Exchange of

Persons, 2101 Constitution Ave., Washington 25, D.C. To insure consideration, *applications must be postmarked no later than Apr. 15.*

The Harvard School of Public Health will give postgraduate scholarships in amounts ranging up to \$5000 to qualified candidates desiring to study at the School during the academic year 1954-55. Eligible for Harvard School of Public Health Postgraduate Scholarships are:

Physicians, dentists, and veterinarians interested in preventive medicine and seeking training in one or more public health specialties leading to either a Master of Public Health or Doctor of Public Health degree.

Industrial physicians seeking training in industrial medicine leading to a Master of Industrial Health degree.

Public health nurses with a college degree and satisfactory field experience who wish additional public health training leading to a Master of Public Health degree.

Public health engineers seeking additional training and research experience in one or more public health specialties leading to either a Master of Science in Hygiene or Doctor of Science in Hygiene degree.

College graduates with academic experience in the natural sciences who desire training and research experience in one of the sciences related to public health and leading to either a Master of Science in Hygiene or Doctor of Science in Hygiene degree.

The deadline for filing scholarship applications is Apr. 30; winners will be announced June 1. Further information may be obtained by writing the Secretary, Harvard School of Public Health, 55 Shattuck St., Boston 15, Mass.

New York University has received capital gifts totaling \$115,236.48 for New York University-Bellevue Medical Center's Institute of Physical Medicine and Rehabilitation. A contribution of \$65,000 was made by the James Foundation of New York, Inc.; through the interest of Mrs. Bernard F. Gimble, an associate trustee of the Medical Center, an additional \$25,000 was given by the Samuel H. Kress Foundation, and \$25,236.48 was received from individual donors. The funds make it possible for the university to meet the final construction costs for the Institute of Physical Medicine and Rehabilitation, which was opened in January 1951.

The Raskob Foundation for Catholic Activities has awarded Georgetown University a grant of \$125,000. The award, to be matched with an additional \$75,000 raised by the university, is to be used over a 4-yr period to further medical education and Catholic medical activities. Part of the funds will be used to support the education of medical students who plan to practice in rural areas. None of the money is to be used for construction purposes or to take the place of activities in the university's regular budget. Francis M. Forster, dean of the School of Medicine, is chair-

man of an advisory committee set up to aid in the best utilization of the grant.

A special scroll award for outstanding contribution to medical education has been presented to **Smith, Kline & French Laboratories** of Philadelphia by the Michigan State Medical Society in Detroit. The award, made at the recent Michigan Clinical Institute, was given to the pharmaceutical firm "in appreciation and recognition of its pioneering contribution" to post-graduate medical teaching through the medium of color television. The Michigan Clinical Institute is the 55th medical meeting since June 1949 at which SK&F has telecast clinics and operations direct from hospital to assembly hall over its closed-circuit color system.

## Meetings and Elections

The Alabama Academy of Science will hold its 31st annual meeting at Huntingdon College, Montgomery, Apr. 2-3.

The 65th meeting of the **American Chemical Society's Division of Rubber Chemistry** will be held in Louisville, Ky., Apr. 14-16. Dynamic tests that indicate a rubber compound's ability to withstand mechanical fatigue, weathering, and roadwear, and chemical advances that give added strength to oil-extended rubber, silicone rubber, and neoprene will be reported in 19 technical papers. Fred C. Wagner of the Du Pont Company's Louisville neoprene plant has been named general chairman of the meeting.

The 30th annual meeting and a clinical scientific program of the **American Heart Association** will be held in Chicago, Mar. 29-Apr. 4. Board and committee members, staff members, and other lay and medical representatives of affiliate and chapter heart associations in all parts of the country will attend a series of business meetings and heart program discussions. The week will be climaxed by a two-day scientific program of the Association's newly formed Section on Clinical Cardiology. The regular scientific sessions, hitherto held in conjunction with the annual meeting, have been combined this year with the Second World Congress of Cardiology which will convene in Washington, D.C., Sept. 12-17.

The **4th Annual Wildflower Pilgrimage** is to be held in the Great Smokies, Apr. 29-May 1. It is sponsored by the University of Tennessee Department of Botany and the Gatlinburg (Tenn.) Chamber of Commerce, with the cooperation of the naturalists in the National Park Service. Both amateur and professional botanists usually enjoy the Pilgrimage.

The **Association of American Geographers** meetings, Apr. 12-14, will have headquarters in the Penn-Sherwood Hotel, Philadelphia. W. F. Christians of the University of Pennsylvania is chairman of local arrangements.

The **Baltimore Philosophical Forum** has been organized to promote a broadened concept of the Arts and Sciences by providing an opportunity to participate in the discussion of matters of philosophic interest. Donald J. Lovell is chairman for 1954.

A celebration meeting on **Paul Ehrlich's 100th Anniversary**—sponsored jointly by The New York Academy of Medicine, the Rudolf Virchow Medical Society in the City of New York, and the Medical Circle—was held in the New York Academy on Mar. 10. Several members of Paul Ehrlich's family participated in the meeting, and the following scientists spoke: Owsei Temkin of the Institute of the History of Medicine, The Johns Hopkins University; Ernst Jokl of the Valley Forge Heart Research Institute; and Cornelius P. Rhoads of Memorial Hospital.

The program of the **Congress of the International Society for Cell Biology** to be held at Leiden, Netherlands, Sept. 1-8 [Science 118, 691 (Dec. 4, 1953)], will consist of twelve symposiums having the following chairmen and moderators: J. Monod, Institut Pasteur, Paris; S. Spiegelman, University of Illinois; G. C. Heringa, University of Amsterdam; A. Frey-Wyssling, Technische Hochschule, Zürich; J. D. Ebert, Indiana University; A. M. Schechtmann, University of California, Los Angeles; G. Pontecorvo, University of Glasgow; C. P. Leblond, McGill University; E. B. Astwood, New England Center Hospital, Boston; G. H. Hogeboom, National Institutes of Health, Bethesda; F. S. Sjöstrand, Karolinska Institutet, Stockholm; F. Zernicke, University of Groningen; H. G. Callan, University of St. Andrews; C. Barigozzi, Università, Milano; R. Latarjet, Institut du Radiium, Paris; J. Holtfreter, University of Rochester; C. M. Pomerat, University of Texas; F. E. Lehman, Universität, Bern; H. Lettré, Universität, Heidelberg; H. H. Ussing, University of Copenhagen; W. H. Arisz, University of Groningen; R. W. G. Wyckoff, American Embassy, London; H. Fernandez Morán, University of Caracas.

Each symposium will include, in addition to the main invitational addresses, six 15-min papers bearing on the particular subject, to be selected by the Dutch organizing committee from abstracts received during the coming weeks. *Abstracts (less than 300 words) should be sent immediately to the secretary of the Dutch committee, Dr. W. H. K. Kars tens, Botanical Laboratory, University, Leiden, Netherlands.* One change in plan is that there will be a separate section for "free" 10-min papers which will meet concurrently with symposiums. Papers submitted for the symposiums, but failing to be selected for oral presentation, will be read by title or may be given at the free sessions. Three of the symposiums will be held under the auspices of the International Union of Biological Sciences as a conference on the "Fine Structure of Cells." Contributors to these sessions will have to furnish, besides the advance abstracts mentioned before, manuscripts of their papers to be published by IUBS in the proceedings of the conference.

A visiting group of French consulting engineers arriving in this country at the beginning of April will meet with a representative group of the members of the Association of Consulting Chemists and Chemical Engineers, Inc., at a luncheon in New York City on Apr. 7. The purpose of the gathering is to establish firmer contacts between American consultants and their foreign colleagues. The meeting is sponsored by the Foreign Operations Administration, Industrial Technical Assistance Division.

The Fourth Middle East Medical Assembly will be held at the American University Medical School in Beirut, Lebanon, on April 9-11. Distinguished speakers from the Arab States, England, and the United States will participate, including Sir Lionel Whitby, General Sam Seeley, Prof. John McMichael, and members of U.S. Army, Air Corps, and Navy Medical Corps. Subjects of especial interest to the region will be discussed. There will be scientific exhibits. The assembly is under the direction of Dr. Hobart A. Reimann.

Under the sponsorship of the National Research Council's Advisory Board on Quartermaster Research and Development, a symposium on methods for evaluating nutritional adequacy and status was conducted on Feb. 25-26 at the Oriental Institute, University of Chicago. The symposium was conducted jointly by the Quartermaster Food and Container Institute for the Armed Forces and the Medical Nutrition Laboratory, Office of the Surgeon General. The program was keyed to methods for evaluating: protein, vitamin, and mineral adequacy, respectively; military rations by use of test animals; and the nutritional status of populations. Concluding the sessions, a round-table discussion was held on body composition in relation to metabolic regulations and activities.

The subject matter of the symposium was organized by Harry Spector, chief of the Nutrition Division, QMFCI, with the assistance of Lt. Col. C. J. Koehn, Medical Service Liaison Officer of the Institute; Lt. Col. Robert Ryer, III, commandant, and Theodore Friedemann, scientific director of the Medical Nutrition Laboratory, Office of the Surgeon General, coordinated the planning with regard to the interests of their organization.

Participants in the conference included nutritionists and medical scientists from the Armed Forces and from research institutions in the United States and Canada.

This year the annual meeting of the North Dakota Academy of Science will be held on the campus of the North Dakota Agricultural College at Fargo, May 7-8. The Academy will award cash prizes for the three best papers written by students, graduate or undergraduate, in any branch of science but representing, at least in part, some original work. The prize money is the gift of A. Rodger Denison, vice president of Amerada Petroleum Corporation.

The first organizational meeting of the Society of Nuclear Medicine was held in Spokane, Wash., Jan. 23. Twelve representatives from various areas in the Pacific Northwest were present and elected an executive committee composed of: pres., Thomas Carlile; pres-elect., Asa Seeds; sec., Rex Huff; and treas., Norman Holter. The first annual meeting is scheduled for May 29-30, at the Benjamin Franklin Hotel in Seattle, Wash. The purpose of this new organization is to promote discussion and communication of knowledge related to nuclear phenomena, as they apply or are likely to apply to the understanding and control of disease. Abstracts for presentation at the first annual meeting may be sent to William H. Hannah, RR 2, Box 896, Bremerton, Wash. Those interested in becoming charter members should make application to Milo Harris, 252 Paulsen Bldg., Spokane, Wash.

The Institute of Industrial Health of the University of Cincinnati announces a *Symposium on Fluorides* to be presented on May 10-12 by the Kettering Laboratory in the Department of Preventive Medicine and Industrial Health. The symposium will be conducted by staff members of the Kettering Laboratory and a number of guest lecturers whose work in the field is contemporary. It will be open to physicians in industry and public health and to other professional persons who are interested in the problem of fluorides. The program has been divided into three daily sessions of talks and discussions on inorganic and organic fluorides, their biological effects on plants, animals, and man, and the associated problems of atmospheric control. Consideration will also be given to legal and economic aspects.

Interested persons should write to the Secretary, Institute of Industrial Health, Kettering Laboratory, Eden and Bethesda Avenues, Cincinnati 19, Ohio. There will be a registration fee. Early application is advised since attendance will be limited.

## Miscellaneous

The first issue of the *ISA Journal*, official publication of the Instrument Society of America, appeared in January. Robert J. Jeffries of Michigan State College is editor. Offices for the new monthly are at 1319 Allegheny Ave., Pittsburgh 33, Pa.

The Gerontological Society, Inc. has announced publication of a quarterly to be known as the *Newsletter of the Gerontological Society*. It will have an initial circulation of approximately 2000 copies. The submission of items for inclusion in the *Newsletter* is invited. These should be sent to Dr. Oscar J. Kaplan, San Diego State College, San Diego 15, Calif.

The National Manpower Council has published a six-point program for more effective utilization of America's scientific and professional manpower resources which would bring significant changes in the function, training, and income patterns of engineers, medical personnel, and teachers. This program repre-

sents the thinking of 66 national leaders in the engineering, medical, educational, scientific, industrial, governmental, and military fields who were called together in conference by the Council last fall. The proceedings of the conference, a 200-page book entitled, *The Utilization of Scientific and Professional Manpower*, has recently been published by the Columbia University Press.

The following chemicals are wanted by the Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 35 W. 33 St., Chicago, Ill.: hafnium carbide; decaborane; trimethylaminoborine; tributylphosphine oxide; chromium hexacarbonyl; molybdenum oxyfluoride; 10-methyl-1,2-benzanthracene; 2-methyl-2-hexanol; N-methylpiperidine; cycloheximid; cyclohexanone peroxide; tetramethyl-p-benzoquinone; N,N,N',N'-tetramethylethylenediamine; n-decanesulfonic acid; disodium methylarsinate; quiniquiphenyl; ptyalins; peroxidase; lycopene; carbonic anhydrase.

## Necrology

**Douglas S. Anderson**, 82, former dean of the College of Engineering and retired president of Tulane University, New Orleans, La., Mar. 2; **Sanford D. Ashford**, 55, engineer for the Interstate Commerce Commission, Washington, D.C., Feb. 9; **Joseph H. Barach**, 71, authority on diabetes and medical director of the Falk Clinic, Pittsburgh, Pa., Mar. 7; **Edwin L. Bartlett**, 70, associate professor of surgery and pathology at the University of California Hospital, San Francisco, Calif., Feb. 22; **Samuel A. Blan**, 82, research chemist, Brooklyn, N.Y., Feb. 17; **Stanley W. Bromley**, 54, retired chief entomologist for the Bartlett Tree Research Company, Stamford, Conn., Feb. 16; **B. Lucien Brun**, 70, retired head of the Dental Department at the Johns Hopkins Hospital, Baltimore, Md., Feb. 19; **Ralph Butler**, 80, former professor of laryngology and vice dean of otolaryngology in the Graduate School of Medicine, University of Pennsylvania, Philadelphia, Pa., Mar. 3; **Theodore Cohen**, 58, former president of the New York Academy of Optometry, author, and lecturer at the Optometric Foundation of New York, New York City, Feb. 12; **Julian Lowell Coolidge**, 80, former president of the Mathematical Association of America, author, and professor emeritus of mathematics at Harvard University, Cambridge, Mass., Mar. 5; **Otto P. H. Diels**, 78, Nobel chemist and professor emeritus of chemistry at the University of Kiel, Kiel, Germany, Mar. 7; **Eleazer J. Dole**, 66, professor of botany at the University of Vermont, Burlington, Vt., Feb. 22.

**Otto P. Geier**, 79, leader in industrial medicine and public health, Cincinnati, Ohio, Feb. 28; **Edward L. Getchell**, 69, professor emeritus and former head of the Mechanical Engineering Department at the University of New Hampshire, Durham, N.H., Feb. 23; **Evert Gorter**, 72, professor emeritus of pediatrics at

Leyden University, Leyden, The Netherlands, Feb. 17; **James B. Herrick**, 92, heart specialist, author, and professor emeritus at Rush Medical College, Chicago, Ill., Mar. 7; **Fred H. Hillman**, 90, botanist, author, and retired seed expert for the Department of Agriculture, Washington, D.C., Feb. 8; **Ludwik Hirschfeld**, 69, serologist and professor of microbiology at Wroclaw University, Wroclaw, Poland, Mar. 7; **Frederick Holborn**, 61, project engineer at the research laboratory of the National Union Radio Corp., Orange, N.J., Feb. 11; **Kotaro Honda**, 83, research metallurgist, Tokyo, Japan, Feb. 12; **Walter R. Jones**, 51, professor of electrical engineering at Cornell University, Ithaca, N.Y., Mar. 8; **Edwin F. Kingsbury**, 67, electrical engineer and inventor for the Bell Telephone Laboratories, Murray Hill, N.J., Mar. 4; **Howard B. Lewis**, 66, research biochemist, author, and chairman of the Biological Chemistry Department at the University of Michigan Medical School, Ann Arbor, Mich., Mar. 7; **Egon K. Lorenz**, 62 radiation specialist for the National Cancer Institute, Bethesda, Md., Feb. 12.

**Louis Mark**, 61, tuberculosis specialist, Columbus, Ohio, Feb. 25; **Charles L. Marlatt**, 90, retired chief of the Bureaus of Entomology and Plant Quarantine, Department of Agriculture, Washington, D.C., Mar. 3; **David Milne**, 77, botanist, Brechin, Scotland, Feb. 18; **John H. Mueller**, 62, professor and head of the Department of Bacteriology and Immunology at the Harvard Medical School, Boston, Mass., Feb. 16; **Arthur Palmer**, 64, author and professor of clinical surgery in the Department of Otolaryngology at the Cornell Medical College, New York City, Feb. 18; **Charles L. Parsons**, 86, former secretary of the American Chemical Society, chief chemist of the Bureau of Mines, and chief engineer of the War Department, Pocasset, Mass., Feb. 13; **James C. Peebles**, 77, dean emeritus of the School of Engineering at the Illinois Institute of Technology, Chicago, Ill., Feb. 18; **Frank R. Pratt**, 77, retired professor of physics at Rutgers University, New Brunswick, N.J., Feb. 25; **William H. Robey**, 83, cardiologist, author, former president of the American Heart Association, and former clinical professor of medicine at the Harvard Medical School, Boston, Mass., Feb. 23; **Walter C. Russell**, 61, professor of agricultural biochemistry in the College of Agriculture and dean of the Graduate School at Rutgers University, New Brunswick, N.J., Mar. 10; **George A. Stinchcomb**, 60, head of the Department of Physics at Heidelberg College, Tiffin, Ohio, Nov. 17; **C. M. Tucker**, 57, professor of botany and plant pathology and chairman of the Department of Botany at the University of Missouri, Columbia, Mo., Feb. 3; **Edwin F. Voigt**, 59, bacteriologist with Lederle Laboratories, Pearl River, N.Y., Feb. 15; **Felix von Oegele**, 92, research chemist, author, and authority on hieroglyphics, New York City, Mar. 9; **Wayland D. Wilcox**, 78, editor and specialist in scientific publishing, Philadelphia, Pa., Mar. 9; **Guy H. Woollett**, 66, research chemist and retired professor of chemistry at the University of Mississippi School of Medicine, University, Miss., Feb. 27.

# Technical Papers

## Electronic Quantitation of Light Absorption and Nuclear Fluorescence in Living Cells

Charles N. Loeser<sup>1</sup> and Carl Berkley

Western Reserve University, Medical School,  
Cleveland, Ohio, and Allen B. Du Mont  
Laboratories, Inc., Clifton, New Jersey

This paper describes a study of the application of electronic methods to the observation and quantitation of the light absorption and nuclear fluorescence of living cells. This work followed upon development of a method of observing nuclear fluorescence in stained living animals by a quartz rod transillumination technique (1), modified for use with near ultraviolet light (2).

The amount of light emitted by the nuclei is, under controlled conditions, an estimate of dye uptake. Certain types of cancer cells, for example, take up more dye and can be distinguished by greater fluorescence on slides (3, 4). For this differential detection, Mellors and Silver (4) devised a microfluorometric scanner.

In the present investigation, for use in the living animal (in the moving blood stream, for example), it was felt that actual television methods, such as those discussed by Young and Roberts (5) and Zworykin and Flory (6) might prove adaptable to rapidly changing phenomena. Therefore, a program of investigation was undertaken of various ways to study nuclear fluorescence by television and other electronic means. Light absorption was soon discovered to be easier to study than fluorescence, especially *in vivo*, because of the higher signal to noise ratio and the consequent more accurate reading.

Observations were made in three ways. In living frogs, transillumination was carried out either by (a) a rod of fused quartz, which carries light from the source to the organ examined by the microscope, or (b) by suspending tissue over the condenser of an ordinary microscope; magnifications up to 440× were used, and higher ones are certainly possible. (c) Living cells, buccal, vaginal, or cervical, were stained directly on slides and placed on the microscope stage.

For the elicitation of fluorescence in the living animal, acriflavine hydrochloride is relatively nontoxic. Rats survive and appear unaffected by intravenous doses of 12.5 mg/kg. Mitotic regeneration of cells with nuclei stained *in vivo* with comparable doses has been reported (7). Concentrations as low as 0.005 percent aqueous solution were used in frogs in the dorsal lymph sac. The smears were stained with 1:100,000 to 1:1000 acriflavine for 30 to 60 sec. Staining takes place without previous treatment.

<sup>1</sup> The senior author wishes to acknowledge his indebtedness to the staff of the Allen B. Du Mont Laboratories, for courteous cooperation and invaluable technical advice and for placing at his disposal equipment for this study. The portion of this study performed at Western Reserve University was supported by a grant from the Life Insurance Fund.

Specimens were examined by two television methods and by two lower frequency scanning methods using somewhat different electronic parts. The principle of examination was in each case the same. The object is studied by a photosensitive scanning device, which electronically displays the value of light and dark areas in respective degrees on an oscilloscope, so that at the same time the picture is viewed by the observer a record is made of the light intensities that pass to the "eye" of the electronic observer. The oscilloscope record is in pulses of variable height, depending on the amount of light transmitted, and of variable width, depending on the area of the specimen.

The most elaborate assemblage used consists of an Image Orthicon camera chain, into the pickup tube of which the microscopic image is focused without intermediate optics. A single scanning line across the television screen is selected from the picture by a Du Mont Type 280 oscilloscope, which so interconnects television screen and oscilloscope that the selected line is shown to the observer by a white "strobe" line. The pulses transferred to the oscilloscope from this line are a direct measure of the light coming through the specimen to the television screen. The less elaborate Vidicon television camera was tested for similar work. Although it proved less sensitive for low light intensities and had lesser resolution, it should be adequate for most studies.

A scanning disk and multiplier phototube, approximating closely that discussed by Mellors and Silver (4), was also tried. The image from the microscope is sent partially to the eye of the observer by a beam splitter in the body of the microscope tube, and partially to the multiplier phototube mounted over the

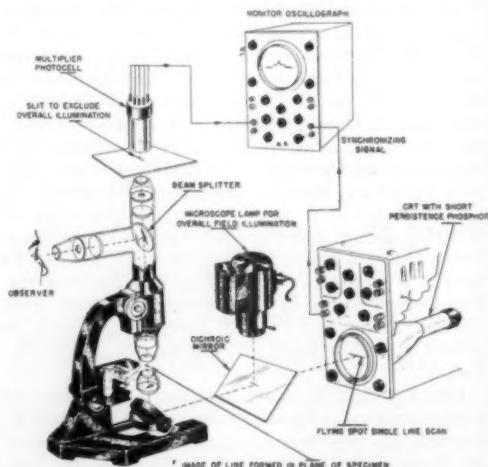


FIG. 1. Schematic diagram of optical system for single-line flying spot scanner.

ocular. It rotates around the periphery over a path reaching the scanned area on an angle. Proper knowledge of the indicated

One can spot of the ray tube are chosen peripherally aeriflavin is directed through the photo with a graph representation

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ocular. Between the phototube and the ocular there rotates an opaque disk with a hole at one side, near the periphery. In rotating, the hole in the disk passes over a portion of the ocular field, permitting light to reach the photocell, and thus a portion of the field is scanned repetitively. Pulses registered by the photocell on an oscilloscope indicated light transmitted. By proper manipulation, it is possible for an observer to know exactly which areas of observation are being indicated on the oscilloscope.

One can substitute for the disk scanning a traveling spot of light from the fluorescent screen of a cathode-ray tube. Different fluorescence emission wavelengths are chosen for specific purposes (in the present experiments, the blue, for the absorption maximum of ariiflavine). As shown in Fig. 1, the scanning source is directed at the mirror of the microscope, passes through the object, to the eye of the observer, and to the photocell. The eye sees the entire microscopic field with a single blue line. Pulse height on the oscilloscope represents degree of absorption; pulse width represents size of the object interrupting the line.

By these methods, it was possible to study not only fluorescence from the stained smears but also absorption. Also, in living tissue—for example, mesentery—with rapidly moving cells in blood vessels, light absorption of any cells that passed the scanning line could be measured. Photographic methods are available to stop any such rapid measurement at any desired moment.

To make fluorescence studies, an exciting wavelength (4100 or 4350 Å) was used with a yellow filter to eliminate transmitted blue light from the source but to permit yellow fluorescence to reach the "eye." For absorption studies, the yellow filter was removed.

Dye uptake was readily measured by studying increase in pulse height accompanying the gradually increasing amount of stain added to a specimen. With smears from known cancer patients, it was possible, since the pulses indicate not only amount of light but also the area supplying that light, to make simultaneous measurements of nuclear light absorption and nuclear size, a definite aid in picking up malignant cells present.

Readily visible *in vivo* nuclear fluorescence did not provide enough light for adequate oscilloscope registration. With faint fluorescence, absorption studies proved satisfactory, the former being proportional to the latter under the conditions used.

Space does not permit more than a word of caution that such quantitation depends upon attention to details of careful absorption studies such as those described by Caspersson (8) and others. The instrumentation described here permits rapid measurement of absorption of light by morphologically identifiable microscopic portions of cells while the cells are alive and moving. The methods provide rapidity of determination, simultaneous measurement of size of object, density, and number of objects (by computers and counters, if desired), at any wavelength. Thus, other wavelengths, other dyes, and other tissues remain to

be explored. The work invites further investigation and will be reported in greater detail.

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## Gallium Purification by Single Crystal Growth

W. Zimmerman, III

Crystal Branch, Solid State Division,  
Naval Research Laboratory, Washington, D.C.

In the course of an investigation of the preparation of intermetallic compounds of the Group III and Group V elements, it became necessary to obtain some high-purity gallium metal. A qualitative spectrographic analysis (1) of the available gallium indicated the presence of 12 elements as impurities (see Table I, column A). The indicated range (2) of concentration of these impurities was from 0.1 percent down to less than 0.0001 percent. The total impurities indicated were about 0.3 to 0.5 percent.

Consideration of the various chemical means of purification (3, 4, 5) showed them to be complex and time consuming. In addition, many of the chemicals needed in the chemical procedures would have to be purified themselves before they could be used. Physical methods of purification were then considered. Distillation was immediately discarded because of the extreme liquid range and high boiling point of the metal. Recrystallization of the metal seemed to offer the best chance for success. Of the recrystallization methods available, zone purification and single crystal growth by the Kryopoulos technique (6) were considered to be the most promising.

It has been shown by previous work at this Laboratory (7) that the rejection of impurities during single crystal growth is extremely high. Hoffman (3) has shown that gallium grows easily. Therefore, despite the excellent results obtained in the zone purification of germanium, it was decided to try a modification of the Kryopoulos technique for gallium.

Since gallium melts at 29.7° C, a simple water bath held at a constant temperature of 38° C and controlled by means of a thermoregulator, was all that was required to keep the gallium molten. A lucite lid on the water bath held the container of gallium and the thermoregulator in position and prevented excess evaporation from the water bath. A thin-walled glass tube with a pointed tip and funnel top was filled with liquid nitrogen and used as a cold finger. Liquid nitrogen

TABLE I. Impurities found in gallium.

Impurity	(A) purchased	(B) After a single growth cycle	(C) After two growth cycles
Mg	TR	VW*	TR
Sn	W	TR-VW	VFTTR
Cu	W	VW	TR
Pb	W	VW	TR
Hg	TR	FTR	VFTTR
Cd	TR	FTR	
Si	TR	VW*	
Al		FTR*	
Mo	TR		
Ge	TR		
Zn	FTR		
Ca	TR		
Ag	VW		

\* See discussion.

Interpretation of symbols: W, 0.1–0.01%; VW, 0.01–0.001%; TR, 0.001–0.0001%; FTR, 0.0001–less than 0.0001%; VFTTR, less than 0.0001%; blank means not detected.

was used in preference to some other coolant, such as dry ice-alcohol, because it was easier to maintain the supply of coolant at the tip of the cold finger where there was no solid matter to block the free supply of liquid.

The first container for the gallium was made of Pyrex; but since there seemed to be a pickup of aluminum, magnesium, and silicon (see Table 1, column B) when this was used, a silica container was made and used for the second crop of crystals.

Gallium single crystals were grown with a minimum of effort by the Kyropoulos technique and samples were taken from the tops and tips of all crystals. The first crop of crystals showed a qualitative improvement by a factor of 10 in the concentration of copper, tin, lead, cadmium, and mercury but showed an increase in magnesium, aluminum, and silicon. A recheck on the latter three showed that the impurities were strongly concentrated as a surface film and that in the body of the crystal there had been only a slight pickup of magnesium and no pickup of silicon and aluminum (Table 1, column B). These first crystals were remelted, and a second crop of crystals was grown. Further purification by a second factor of 10 was obtained in the lead, tin, and mercury content and by the elimination of spectrographically detectable amounts of silicon, aluminum, molybdenum, cadmium, zinc, germanium, calcium, and silver, all of which had appeared in the initial qualitative analysis (Table 1, column C).

Thus, after two cycles of crystal growth, there were only five elements remaining that could be detected spectrographically as impurities. Eight others had been reduced so that they were no longer detectable. All the impurities had been reduced by a minimum factor of 10 and some by a factor of more than 1000. The total impurity content of the second crop of crys-

tals was not more than 0.005 percent and probably nearer 0.001 percent.

Since this purity was sufficient for our purposes, no additional regrowth was attempted. It is felt, however, that by continued growth further purification by at least one factor of 10 could be achieved.

#### References and Notes

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#### Estimation of Blood Loss in Hookworm Infestation with Fe<sup>59</sup>: Preliminary Report<sup>1</sup>

Th. Gerritsen, H. J. Heinz, and G. H. Stafford<sup>2</sup>

*South African Institute for Medical Research, Johannesburg, and Council for Scientific and Industrial Research, Pretoria*

A number of workers (1, 2, 3) have expressed the belief that in cases of hookworm infestation the anemia frequently observed could be caused solely by the blood lost from the intestines. In a review of the subject Lane (4) concludes that blood loss is the most probable reason for hookworm anemia. Wells (2) attached *A. caninum* to the intestinal mucosa of living dogs and from iron balance observations calculated the maximum loss of 0.8 ml blood per worm per day, but he allowed for a considerable variation in the blood consumption of individual worms. Hahn and Offutt (5) found a method of studying the blood loss in hookworm infestation of dogs using radioactive iron.

We have used a similar technic on three human patients, who, except for the hookworm ova found in their stools, were otherwise healthy. Our purpose was to determine whether the blood loss per worm per day was constant (improbable) and to what degree the blood loss was responsible for the comparatively low hemoglobin values of our patients.

Our method was briefly as follows. Approximately 40 µc of Fe<sup>59</sup>, in acid solution containing less than 1 mg of iron, were sterilized, buffered, mixed with 20 ml of the patients' own heparinized plasma, and injected intravenously. Small samples of blood were taken at intervals of 2 or 3 days and the radioactive content measured. After about 8 days, this became approximately constant and the collection of stools was

<sup>1</sup> This paper is published with the permission of the South African Council for Scientific and Industrial Research.

<sup>2</sup> We wish to thank Mr. L. H. Stein for many valuable discussions during the early part of this work, Miss H. Benjamin for the diligent way in which she carried out much of the routine work, and the staff of the non-European hospital in Johannesburg for their generous cooperation at all times.

then started and continued for about 12 days. The stools were collected in periods of 3 days and lumped together for extraction of the iron and measurement of the activity. Finally, after the last 3-day period, the patient was dewormed and quantitative worm counts made on the stools for the next 5 days. Where possible, ova concentration methods were employed after the fifth day to check the efficiency of deworming.

The radioactivity of the blood was determined with an end-window Geiger counter after the sample had been ashed and electroplated on to copper disks, following essentially the method described by Vosburgh, Flexner, and Cowie (6). The stools were dried with concentrated  $HNO_3$  on a water bath, ashed, extracted with  $HCl$ , and the activity of the liquid measured with a Veall type (7) liquid counter. A reference solution of  $Fe^{59}$  was also made from each batch used for intravenous injection. Then if

$C_s$  = counts/min in the liquid counter of the stool ash extract,

$C_b$  = average counts/min ml blood over the period during which the stools were collected,

$S_e$  = counts/min ml of the reference solution electroplated,

$S_f$  = counts/min in the liquid counter of some of the same reference solution,

$V_s$  = volume of stool ash extract in ml,

the blood loss is given by

$$(C_s \times S_e \times V_s) / (C_b \times S_f).$$

Our results, as summarized in Table 1, appear to support Wells' conception of a considerable variation in the blood loss per worm. The daily loss of 10–20 ml (i.e., 5–10 mg iron) would seem to account for the hemoglobin values obtained. They are definitely low for Angola Africans, who have a high iron intake (8). The observed hookworm loads combined with a normal iron intake should, therefore, produce a marked anemia.

We feel for the present unable to explain the high blood loss of patient A, harboring such a small worm load, unless there are one or two profusely bleeding

TABLE 1. Hemoglobin values; blood loss during subsequent 3-day periods; average blood loss per day; number of worms recovered from the stools after deworming; and blood loss per worm per day for the 3 patients examined, and one control.

Patient	Hb (g %)	Blood loss (ml)							Blood loss per worm per day (ml)
		1st period	2nd period	3rd period	4th period	Avg/day	Hookworms		
M	10.7	33.5	26.8	25.1	28.7	9.5	368	0.026	
A	13.1	48.6	30.8	47.9	—	14.1	63	.22	
C	13.1	71.2	60.0	42.8	51.6	18.8	354	.053	
Control	—	2.3	2.3	2.0	—	0.7	—	—	

injuries left by the worms. To what degree blood loss is due to these bleeding injuries, or to the consumption of blood by the worm, remains to be determined in future experiments.

On the basis of our results, it is not necessary to argue that the anemia is caused by the effect of toxins (9). However, our results have been obtained on patients with light loads in the age group from 18 to 30 yr, and various factors such as adaptation and immunity might counteract the full effect of hookworm toxins and so affect our conclusions. There is, therefore, a need for further studies on younger patients and those with heavier hookworm loads.

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#### Virulence in *Pasteurella pestis*<sup>1</sup>

E. Englesberg, T. H. Chen, J. B. Levy,  
L. E. Foster, and K. F. Meyer

*George Williams Hooper Foundation,  
University of California, San Francisco*

Studies on the nature of *Pasteurella pestis* infection have suggested that at least two factors contribute to the virulence of this bacterium: (a) the envelope substance (Fraction I) produced by this organism (1–3), which has been shown to protect it from phagocytosis (4) and probably blocks the action of antibodies on the cell (4), by virtue of the freely soluble nature of this substance (3); and (b) toxin production (1, 2, 5, 6), which no doubt is responsible for death from this disease (4). Since avirulent *P. pestis* have been found which produce both envelope and toxin, the possibility was suggested that virulence in this organism may be based upon the quantity of these substances produced. In order to investigate this possibility, a comparison of several virulent and avirulent strains was undertaken.

In initial experiments, various virulent and avirulent strains were tested for their ability to produce toxin and envelope in a casein hydrolysate mineral glucose medium at 37° C (3). A few virulent and avirulent strains, however, did not grow in this medium at this temperature. In the case of those strains that did grow, cell yields were so diverse that accurate estimates of toxin and envelope production were impos-

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TABLE 1. Comparison of the quantity of toxin and envelope antigen (Fraction I) produced by several virulent and avirulent strains of *P. pestis*.

Strains	Envelope antigen (μg/mg dry wt.)	Toxicity (No. LD <sub>50</sub> /mg dry wt.)
Virulent		
B741	150	29
195/P	140	20
New Mexico	140	32
Yreka	138	45
Shasta	137	42
Alexander	127	23
Avirulent		
B1456#4	121	25
A1122	110	9
B868#8	104	22
B2764#6	94	23
E.V.76	62	33
F7793#10	52	13
14	30	30
TRU	25	0
Harbin	10	0

sible. To avoid these difficulties, the various strains were subsequently cultured on hormone agar (7), which produced excellent growth of all strains tested.

The following procedure was employed. Strains were cultured on hormone agar for 72 hr at 37° C. The cells were washed off with saline and precipitated with 2 vol of acetone at -70° C. The cells were then collected by centrifugation and dried by several washings with acetone. The residual acetone was removed by placing the cells in a desiccator over concentrated H<sub>2</sub>SO<sub>4</sub> and evacuating. Weighed samples of the various dried powders were extracted with saline, the cells were spun down, and precipitin tests using anti-Fraction I serum and intravenous mouse toxicity tests were performed on the supernatant fluid (3).

The virulence of the strains employed was tested by subcutaneous injection in mice. All strains that killed 50 percent of the mice with less than 300 organisms were termed virulent, whereas those that failed to kill when 1 × 10<sup>4</sup> organisms were administered were considered avirulent.

The following virulent strains were tested: Yreka, B741, Alexander, Shasta, and New Mexico, all of which were isolated from cases of plague on the West Coast, and strain 195/P, which was obtained from the Haffkine Institute, Bombay. Avirulent strains employed were A1122, E.V.76, B2764#6, B1456#4, B868#8, F7793#10, 14, TRU, and Harbin.

The results (Table 1) demonstrate a positive correlation between virulence and quantity of envelope produced, thus suggesting that envelope production must reach a given level before it is effective in combating the host defenses. Although the virulent strains do produce more toxin on the average, it is clear that high toxicity alone is not sufficient to render an organism virulent. This is shown quite clearly by avirulent strains E.V.76 and 14, both of which produce more

toxin than three of the virulent strains. It is interesting to note that, although E.V.76 is able to multiply in mice when inoculated intravenously, producing necrosis in the liver and spleen before being eliminated and causing death as a result of an active plague infection when administered in large doses of about 1 × 10<sup>5</sup> organisms, strain 14 shows no multiplication and produces no pathological signs (8). The difference in behavior of these two organisms *in vivo* may very well be explained by the lower envelope production on the part of strain 14. Similarly, the relative avirulence of E.V.76 may be interpreted on the basis of its comparatively lower envelope production as compared with that of virulent strains. The fact that A1122 produces more envelope substance than E.V.76, yet fails to produce pathological signs in mice (8), may be attributed to the relative atoxicity of the former.

The similarity between the avirulent B1456#4 and the virulent Alexander strains with respect to quantity of toxin and envelope substance produced would seem to indicate that, although high levels of envelope and toxin production appear to be essential for virulence, these are not the only factors involved. Since virulence is a measure of the ability of a bacterium to grow and cause disease in a particular host, all aspects of energy metabolism and assimilation, for example, which may conceivably have no direct bearing on toxin and envelope production *per se*, may be involved here. The apparent correlation between virulence in *P. pestis* and catalase production (9) should be noted.

Experiments to be reported in detail elsewhere have demonstrated that the purified envelope substance and lyophilized lysates of avirulent strains (3) were as effective in immunizing mice as the corresponding antigens isolated from virulent strains. (In the pneumoococcus, avirulent strains have been isolated which produce small amounts of capsular material and yet are able to immunize against virulent strains [10, 11].) Furthermore, recent studies indicate that *P. pestis* toxin produced from E.V.76 (5) is similar in physiological effect to that produced from virulent strains (12). These results eliminate the possibility of a "mouse virulence antigen"—that is, one present solely in virulent *P. pestis*—and thus add further weight to the observed quantitative relationship between envelope and toxin production and virulence.

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## A New Mercury Manometer for Student Use

R. E. Ranney

Department of Physiology,  
University of Colorado, School of Medicine, Denver

A new approach to the design of a mercury manometer system for direct blood pressure recording to replace the time-honored, but often erratic, glass U-tube manometer has resulted in a much more student-proof apparatus in which the unique physical properties of plastics have been utilized.

**Construction.** Figure 1 shows the complete manometer-pressure bottle system.<sup>1</sup> The manometer is made of a single block of lucite, in which is bored a right-angular version of the traditional U. The float is accurately machined of hard rubber to fit one manometer bore, so that mercury creepage is minimized. A lucite float shaft guide is turned to fit snugly into the top of the vertical bore. Nipples, cemented into the other vertical bore and into a connecting hole drilled on the side of the manometer, furnish connections through vinyl tubing to the pressure bottle and to the arterial cannula. A mounting bracket is fashioned by hard soldering a triangular plate to a length of brass rod.

The pressure bottle unit consists of a bottle holder, a valve-and-pressure-tube assembly, and a 16-oz polyethylene bottle. The bottle support is made by bending a piece of stainless steel into a U-shape, which is welded to a stainless steel base. A brass bar, tapped to provide threads for a screw, is attached to the open end of the support. A round pressure plate is fitted to one end of the screw. A knurled knob is attached to the other end.

The valve-and-tube assembly consists of a rubber stopper through which are passed two lucite tubes, 2 and 12 in. in length, respectively. The longer tube is connected to the manometer. Over the upper end of the shorter tube is placed a simple "squeeze" valve consisting of a short length of rubber tubing in which a glass bead has been placed. The valve-and-tube assembly is clamped in the top of the pressure bottle by the bottle cap through which the tubes extend.

**Application.** After a base line has been established, the arterial blood pressure of an experimental animal may be approximated by screwing in the pressure plate, which consequently increases the pressure in the system. To flush the system, the pressure plate is advanced as far as possible, the tube between manometer and bottle is clamped, and additional air is introduced into the bottle by withdrawing the pressure plate and simultaneously squeezing the ball valve.

The manometer may be modified for electro-sensitive paper recording by placing a binding post, which contacts the mercury, in the manometer near the base of the U and by extending the wire shaft completely through the float. These modifications provide a low-

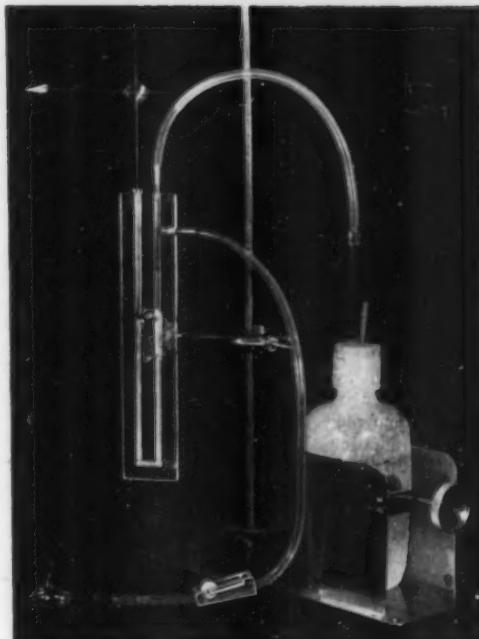


FIG. 1. Plastic mercury manometer and pressure bottle system.

resistance path for the current from power source to recording paper.

**Characteristics.** One of the outstanding advantages of this manometer is the complete interchangeability of parts. Floats, float guides, and manometers are all machined to the same specification and need not be matched to fit. In addition, the one-piece design and absence of fragile extensions have resulted in a long estimated useful life for each manometer. Finally, the few working parts of the entire system decrease the chance of failure.

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## Further Investigations into the Modification of Radiation Sensitivity Afforded by Cobalt

W. Parr, T. O'Neill, S. Bush, and A. Krebs  
*U.S. Army Medical Research Laboratory,  
Fort Knox, Kentucky*

In light of recent developments in the clinical usage of cobalt (1) and its ability to modify radiation sensitivity (2, 3), it appeared desirable to investigate the possible effects resulting from the utilization of cobalt under various conditions of administration.

Four hundred female Swiss-Wabster albino mice ( $25 \pm 1$  g) were divided into four groups: group A,

<sup>1</sup> The author will furnish a more detailed description of this apparatus to anyone interested in duplicating it.

Purina stock chow diet; group B, cobalt diet; group C, Purina stock chow diet and irradiation; and group D, cobalt diet and irradiation.

The normal diet consisted of Purina stock chow pellets. The cobalt diet consisted of dried Purina chow pellets prepared daily by immersion for 2 min in an aqueous 2-percent solution of  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  (4).

To give all animals easy access to food, the pellets were scattered in the cedar shavings that covered the bottom of the cage. Thus, the cobalt-fed animals ate *ad libitum* the cobalt-treated surfaces or the less enriched cores of the pellets. Groups of animals were kept on this cobalt diet for 5, 8, and 36 days before and for 15 days after irradiation. In another group, the animals were fed a cobalt diet only throughout the observation period after irradiation. To study the effects of feeding conditions, other groups of mice were fed through attached food baskets. This inhibited their random choice of food.

The irradiations were made with a Kelley-Koett deep therapy x-ray unit operated at 200 kv, 6 ma, inherent filtration equivalent 0.25 mm Cu, 1 mm Al plus 0.5 mm Cu added filter, target specimen distance 28 cm, 48 r/m in air, total dose 720 r in air. The animals were irradiated in a well-ventilated lucite cage in groups of 10 (5 animals from group C and 5 from group D) and observed for 30 days after irradiation. Deaths were recorded every 24 hr.

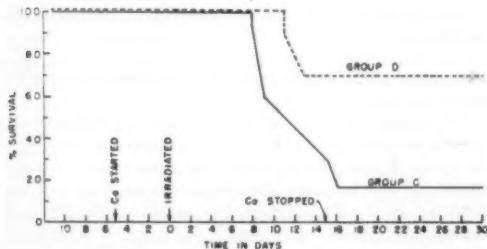


FIG. 1. Survival of mice after total body irradiation (720 r). Cobalt was fed to groups B and D for 5 days before and for 15 days after irradiation. Groups A and B (nonirradiated controls) had no deaths during the 35-day study. Group C: stock-fed irradiated animals. Group D: cobalt-fed irradiated animals.

Animals that were fed the cobalt-treated pellets for 5 days before and for 15 days after exposure to irradiation showed a decrease in radiosensitivity (Fig. 1). A 3-day extension of the cobalt feeding period prior to irradiation gave comparable beneficial effects, in confirmation of previous publications (5). However, mice that were fed 36 days before and 15 days after irradiation exhibited no modification in radiation sensitivity (Fig. 2). Results similar to those in Fig. 2 were obtained when the cobalt food was offered immediately after exposure to the radiation and was continually offered throughout the 30-day observation period. The data indicate that the beneficial effect of cobalt on radiation sensitivity does not occur when

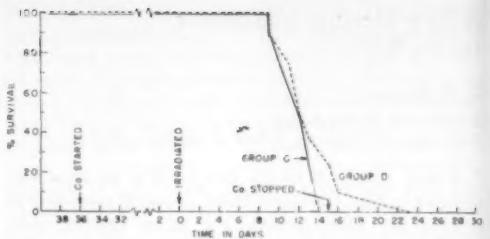


FIG. 2. Survival of mice after total body irradiation (720 r). Cobalt was fed to groups B and D for 36 days before and for 15 days after irradiation. Groups A and B (nonirradiated controls) had no deaths during the 66-day study. Group C: stock-fed irradiated animals. Group D: cobalt-fed irradiated animals.

cobalt is given over longer periods of time, either before or after irradiation. This could mean that the greatest protection occurs at the time when the stimulus to the blood-forming system is exercised (6, 7) and is not associated with the polycythemia that usually accompanies cobalt administration over long periods. Bethard, Skirmond, and Jacobson (8) expressed a similar interpretation of their findings while studying the effects of  $\text{P}^{32}$  radiation on cobalt-treated and non-cobalt-treated rats.

The manner in which the cobalt diet was offered to the animal, as well as the time element involved, had an important influence on radiation sensitivity. Animals that were fed cobalt food through the attached food baskets not only failed to develop a resistance to irradiation but died earlier than the irradiated animals that were fed the normal chow through food baskets (2). A possible explanation for this may be found in the fact that 20 percent of the control cobalt-fed animals died, thus suggesting a possible cobalt toxicity.

The exact amount of cobalt eaten by the animals under the different experimental conditions remains to be determined. The amount is probably relatively small in experiments with beneficial effects, surely under the previously estimated 3 to 4 mg. From the investigations made by Gardner (1) on the clinical usage of cobalt, it can be tentatively estimated that the mouse will tolerate about 0.04 to 0.05 mg cobalt per day without noticeable ill effects. Appropriate experiments for more detailed knowledge are under way.

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## Intracerebral Injection of Procaine into the Globus Pallidus in Hyperkinetic Disorders

Irving S. Cooper

Department of Neurosurgery,  
New York University, New York

In April, 1953, the author described a new investigative technic in the neurosurgical treatment of hyperkinetic disorders (1, 2). This technic consists of surgical occlusion of the anterior choroidal artery in order to selectively decrease or obliterate the blood supply to certain intracerebral structures which are dependent upon this vessel for their blood supply. The structure most affected by occlusion of the anterior choroidal artery is the medial segment of the globus pallidus (3, 4).

During the past year it has been demonstrated that, in selected, far-advanced cases of Parkinsonism, surgical occlusion of the anterior choroidal artery may produce varying degrees of alleviation of resting-type, or pill-rolling, tremor. The most significant result of this procedure, however, has been reduction of Parkinsonian rigidity which was so severe as to incapacitate the patient by rendering him incapable of useful voluntary motor function. The operation has not been successful in every instance in which it was carried out. The percentile incidence of successful results that can be anticipated will depend upon a long-term study upon selected patients, which is now in progress. In certain cases, however, the relief of rigidity has been significant enough to permit the reversal of rigid, dystonic deformities which were heretofore considered to be irreversible (Fig. 1).

The results of anterior choroidal artery occlusion have been confirmed by several independent investigators. Doctors J. Lawrence Pool, A. Earl Walker, James Gardner, T. I. Hoen, W. Scoville, C. Bertrand, J. A. MacLean, and David Fairman have informed the author of cases in which significant lessening of resting tremor or rigidity, or both, followed surgical occlusion of the anterior choroidal artery in patients with far-advanced Parkinsonism.

The results of this investigation raised the question of proper selection of patients for anterior choroidal artery occlusion. Since the operation has not been successful in every case in which it was performed, and since this procedure carries the operative risk of a craniotomy in chronically ill patients, the importance of proper selection of patients is obvious. This problem led us to investigate the possibility of selectively blocking the globus pallidus as a diagnostic procedure. Such a procedure might enable one to predict whether a more destructive operation would be of value in any particular case.

Anatomical studies led us to conclude that a small caliber ventricular needle could be introduced into the brain through a trephine opening in the skull, and brought to lie in close enough apposition to the medial and intermediate segments of the globus pallidus to permit injection of procaine into that area of the

brain without using a stereotaxic instrument or performing a major transcerebral operation. The coronal and horizontal planes in which the globus pallidus lies are illustrated in Fig. 2. The point of intersection of these planes on the surface of the skull determined the site of trephination for this procedure. The third dimension, or sagittal plane, of localization of the globus pallidus was found to lie from 4.5 to 5.0 cm medial to the dura, when the brain is unfixed and *in situ* in the skull.

It is the purpose of this communication to report that procaine injection into the substance of the brain in the region of the medial and intermediate segments of the globus pallidus has been performed 10 times, and in 8 instances has resulted in temporary cessation of resting tremor and alleviation of rigidity in the contralateral extremities. The technic involved placing the patient in a sitting position on the operating table with the head supported by the Craig neurosurgical headrest. Under local anesthesia a small trephine opening is placed in the skull 1.5 cm behind the level of the tragus of the ear and 1.0 cm above the uppermost level of the helix of the ear. A small opening is made in the dura, and a small caliber ventricular needle is placed



FIG. 1. (Upper) Marked dystonic deformity of long standing due to rigidity of Parkinsonism. (Lower) Reversal of deformity following alleviation of rigidity by surgical occlusion of the anterior choroidal artery.

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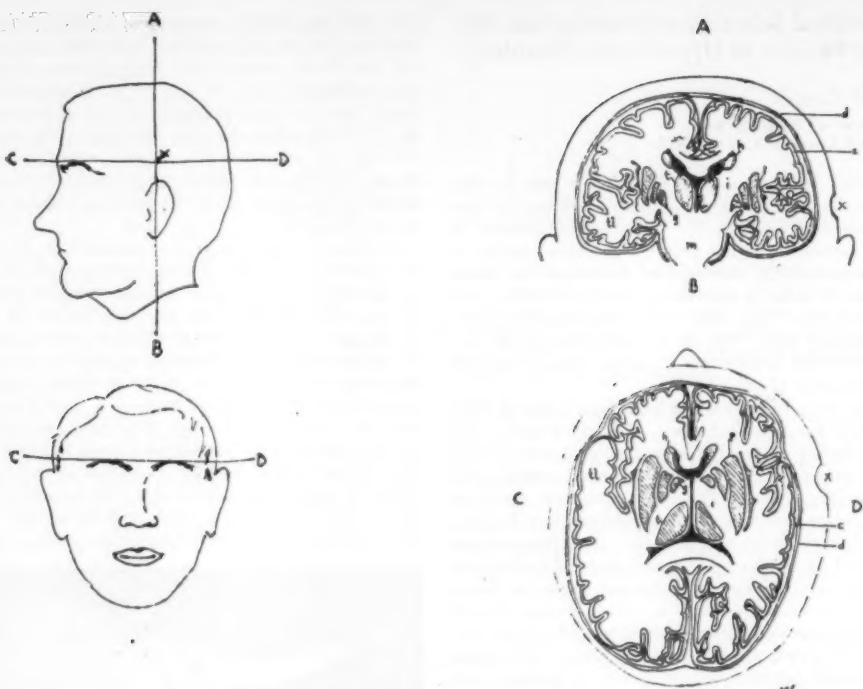


FIG. 2. Diagrammatic localization of site of skull trephination for direct injection of procaine into globus pallidus. AB represents coronal plane in which globus lies. CD represents horizontal plane in which globus lies. X denotes site of intersection of these planes on skull, at which point trephination is made. Sagittal plane in which globus lies is 4.5 to 5.0 cm medial to dura beneath point X. c, cortex; i, internal capsule; t, thalamus; d, dura; m, midbrain; tl, temporal lobe; g, globus pallidus; p, putamen.

horizontally into the brain to a depth of 4.5 cm beyond the dura. At this point the tip of the needle lies between the intermediate and medial segments of the globus pallidus. Five minims of 0.5 percent procaine is then injected into the brain. If no change in tremor or rigidity occurs the needle is advanced 0.25 cm and the injection repeated. On occasion, the injection is repeated once more with the needle at a depth of 5 cm.

In 8 instances in which this procedure was followed, tremor and rigidity in the contralateral extremities were markedly reduced or totally alleviated within 2-5 min after the first injection. Tremor and rigidity remained absent as long as 48 hr, although there was usually some return of rigidity within 3 hr, and return of rigidity was seen in one case within 45 min after injection. In no case was motor weakness encountered. This is due to the fact that the injecting needle encounters the basal ganglia without coming into contact with the internal capsule. No untoward sequelae have been encountered in these 8 experiments. Control injections into the tip of the temporal lobe have failed to produce any change in contralateral tremor or rigidity.

This technic of injection of procaine or neurolytic

agents into areas of the brain concerned with motor function deserves exploration. In the case of the hyperkinetic disorders it may enable one to seek out the intracerebral area of structures which, if destroyed, will afford relief of hyperkinetic symptoms. Moreover, that fact that it relies upon such relief of symptoms to designate that area with which the investigator should concern himself indicates that it will point out a dynamic physiologic landmark rather than an empirical anatomical landmark. Roentgenographic methods of anatomically documenting the locus of such a physiologic landmark in individual cases are under investigation.

**Addendum.** Since submission of this report the author has learned that Dr. Narabayashi in Japan has injected procaine in oil into the globus pallidus in humans, using a stereotaxic instrument.

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Received December 16, 1953.

## Communications

### Specific Precipitating Activity of Plant Agglutinins (Lectins)<sup>1</sup>

BLOOD group specific agglutinins have been detected in the seeds and other parts of certain plants (1-7). They promise to have theoretical and practical importance, and we are engaged in a study of their immunochemical properties. One of us has proposed (7) the term "lectin" (from the Latin *lego*, to choose or pick out) for these and other antibody-like substances.

We have recently found that a number of these lectins are also specific precipitins. For instance, a protein purified from lima bean (*Sieva*) extracts by alcohol-water fractionation at 0° C precipitates with the salivas of secretors, but not of nonsecretors, of blood groups A and B, but not of O. This preparation also precipitates with a solution of A substance made by Morgan's method (8) from hog gastric mucin, but does not precipitate with the polysaccharides of *pneumococcus I*, Friedländer B, gum arabic, and other unrelated substances. An extract of *Dolichos biflorus* (5) precipitates with the saliva of secretors of subgroup A<sub>1</sub>, but not with A<sub>2</sub> or other groups, and precipitates weakly with hog A. The proteins of beans which do not agglutinate human erythrocytes do not precipitate with any human salivas or with hog A; nor do the proteins of beans which nonspecifically agglutinate all human erythrocytes precipitate with salivas of blood group A or with hog A substance. The antibody-like behavior of the lectins thus extends to specific precipitating power for blood group substances.

It is thought that a study of this phenomenon may yield information about the quantitative course of the reaction, the heat of reaction and temperature coefficient, and the antigenic structure of the blood group antigens. A detailed account of some of our experiments is in preparation.

WILLIAM C. BOYD

ELIZABETH SHAPLEIGH

Boston University School of Medicine

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<sup>1</sup> This work was made possible by support extended to Boston University by the U.S. Atomic Energy Commission, under contract No. AT(30-1)-1395, the Navy Department (Office of Naval Research) under contract No. Nonr-492 (01), and by a research grant, H-1076 (2), from the National Heart Institute, Public Health Service.

Received January 18, 1954.

### Geology and Coal Resources of the Centralia-Chehalis District, Lewis and Thurston Counties, Washington

RECENT geologic investigations by the U.S. Geological Survey in the Centralia-Chehalis district, Washington, are of economic interest to the coal and petroleum industries of the state. A comprehensive report on this area, now in preparation, describes large reserves of subbituminous coal and defines areas of marine sedimentary rocks and structures that may be favorable for the accumulation of oil and gas. The information contains data useful in the development and utilization of the coal, which furnishes one of the bases for the potential industrial growth of this region and aids in delimiting new areas favorable for exploration for oil and gas.

The rocks exposed in the Centralia-Chehalis district range in age from early Tertiary (Eocene) to Quaternary. The total thickness of these rocks is more than 12,000 ft. The sedimentary sequence includes marine, brackish-water, and nonmarine sedimentary rocks with interbedded volcanics. The beds are folded and faulted and, in most places, are now buried by poorly consolidated till and outwash from Pleistocene glaciers and by Recent alluvium. The Eocene and Oligocene rocks are intruded by dikes and sills of basalt and gabbro.

The structural history of the rock units in the Centralia-Chehalis district began in Eocene time with subsidence of a north-trending geosyncline and deposition of the McIntosh formation. Upwarping and volcanic activity occurred along the margins of the geosyncline during middle and late Eocene time. Local uplifting, adjacent to the area mapped, accompanied the extrusion of andesite flows of the Northercraft formation during the early part of late Eocene time. The geosyncline was divided into a number of separate basins of deposition during this period. There was no major break in sedimentation, however, in the deeper part of the basin, which occupied most of the mapped area.

The Skookumchuck formation and the Lincoln formation of Weaver were deposited on top of the Northercraft formation in later Eocene and Oligocene time. The deposition was accompanied by periodic warping of the floor of the basin, which resulted in an interfingering of nearshore and coal-bearing deposits with marine beds. Most of the present structural features in the area were formed during early Miocene time, a period of marked deformation and erosion. Slight downwarping occurred in late Miocene and Pliocene time, and faulting has continued to the present, as is evidenced by earthquake shocks of 1950 that probably centered along one or more of the faults in the area.

At least 14 different coal beds have been mined in the Centralia-Chehalis district. The coal beds range in thickness from a few inches to 40 ft and have an average thickness of 6 to 8 ft. Most of the minable coal is

of subbituminous C rank with an average of 8650 Btu on an "as received" basis. The ash content is usually high, ranging from 5 to 25 percent and averaging about 10 percent. When exposed to the air, the coal slacks readily because of its high moisture content, which ranges from 16 to 35 percent.

Nearly 15,000 ft of drilling between 1949 and 1951 yielded information on the extent, thickness, physical characteristics, and reserves of the district's coal. This information, combined with information obtained by mapping and prospecting, shows that the district contains more than 3.5 billion short tons of coal, of which about 40 percent is considered recoverable with present mining methods. During 1951, four mines were operating in the district and produced a total of 52,500 short tons of coal.

As early as 1901, the presence of a thick sequence of marine sedimentary rocks in the Centralia-Chehalis area encouraged the search for oil and gas. Since that date, there has been intermittent exploration, and prior to July, 1952, 14 test holes were drilled within the area. The results of this drilling have not been encouraging, but small shows of gas have been reported. The McIntosh formation of late middle Eocene age, which includes a thick sequence of marine siltstone with interbedded sandstone, is considered the most favorable formation to test for oil and gas. Seven of the test wells drilled in the area are reported to have penetrated rocks of the McIntosh formation. Shows of gas were reported in all these test holes; and a show of oil was reported from a well drilled on the Lincoln Creek uplift, in the western part of the mapped area.

PARKE D. SNAVELY, JR.  
R. D. BROWN, JR.  
ALBERT E. ROBERTS  
W. W. RAU  
LINN HOOVER  
M. H. PEASE, JR.

*U.S. Geological Survey  
Portland, Oregon*

Received March 1, 1954.

### A Dehydrator for Direct-Current Amplifiers

The direct-current amplifier is extremely sensitive to minute variations in grid voltage. This sensitivity is required for operation but also is a property that introduces considerable error into experimental data obtained with its use under certain conditions. The phototube amplifier in the Beckman DU Spectrophotometer was often found to be unstable in humid weather, as indicated by continuous fluctuations in the galvanometer needle. Since the battery voltage source was constant, the instability was assumed to be caused by variations in the grid voltage. The latter could result from a variable d.c. ground path in parallel with the 2000 megohm grid resistor (the phototube load resistor). The grid voltage variation proved to be due to moisture condensed on the grid resistor, as shown by stabilization after drying. Although the

cartridge containing silica gel may successfully perform this function, the following system was found to be more rapid and effective.

Two of the mounting screws on the front panel of the amplifier case were replaced by longer screws that had been drilled lengthwise to permit the passage of air. To these screws were connected the intake and outlet hoses of a recirculating drying system that consisted of an electric double-action piston pump to circulate the air, a cotton filter to remove any oil from the pump, and a tube containing the desiccant (indicating silica gel). The color change from blue to pink indicates when the tube of desiccant must be changed. Several tubes of desiccant may be kept on hand and, when necessary, dried in an oven or by perfusion with hot air. The pump should be turned on about an hour before the amplifier is to be used, unless the atmospheric conditions have been especially humid, in which case more time may be necessary.

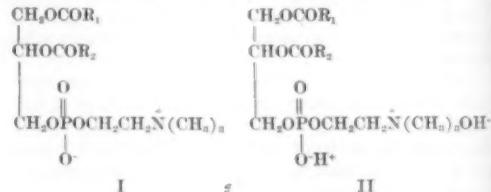
STERLING PIERCE  
GAUTH MILLER

*Department of Biological Sciences  
Stanford University, California*

Received February 12, 1954.

### Depiction of the Lecithin Molecule

DESPITE the fact that experimental evidence serving to establish the zwitterion structure (I) of lecithin on a firm basis was provided by a number of investigators about 20 yr ago (1), there has been consider-



able reluctance to discard the archaic and misleading depiction II. Thus, the structure of lecithin continues to be represented as II (or even more naive representations in which the nitrogen atom is joined to five substituents) in current literature and in otherwise modern and up-to-date biochemistry textbooks.

In a recent series of papers, Baer (2) has spoken more and more positively in favor of the old representation II on the basis of the fact that ultimate analyses of crystalline lecithins and structurally related substances indicate the presence of the elements of a molecule of water in addition to those predicted from a consideration of formula I. Baer's painstaking compilation of analytic data on a number of lecithins isolated from natural sources, in addition to those based on his own elegantly prepared synthetic products, would seem to leave little doubt that such substances characteristically incorporate a molecular equivalent of water within their crystal lattices. However, the presence of what is usually termed "water of

crystallization" in crystals of substances of polar character is not unusual and is not customarily assigned any special structural significance. In any case, the simultaneous occurrence of both hydrogen and hydroxyl ions in the lattice of a crystalline substance is simply untenable.

The question of how to represent a single molecule of a substance of this type, which would be expected to be bound more or less strongly by electrostatic forces to other polar molecules of the same or different constitution in its immediate vicinity, is difficult to answer with finality because of its doubtful real significance. But for pedagogic reasons, if for no other, depiction of the hypothetical isolated lecithin molecule as a zwitterion (I) cannot be seriously questioned as being superior to those others that have been used in the past.

DAVID R. HOWTON

Department of Physiological Chemistry,  
School of Medicine,  
University of California at Los Angeles

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Received January 13, 1954.

## Ground Water in the Navajo Country

IN the semiarid Navajo country the ever-urgent problem is the development of adequate water supplies. The Navajo country in northeastern Arizona, northwestern New Mexico, and southeastern Utah occupies about 25,000 mi<sup>2</sup>. This region is a high plateau that has considerable relief expressed by mountains, mesas, buttes, and deeply cut canyons. Most of the area lies between 5000 and 7000 ft above sea level.

The climate varies widely according to altitude and topography. The average yearly rainfall ranges between 6½ and 13 in. However, the yearly precipitation is as little as 1½ in. in the desert zones. The streams, which are mostly intermittent, drain radially from the central part of the area into the San Juan River on the north and into the Little Colorado River on the south. A few stretches of some streams have perennial flows sustained by snow-melt in the mountainous areas and by springs discharging from water-bearing rocks.

The occurrence of ground water in the Navajo country is directly related to the complex stratigraphic relationships of the geologic formations and their structural attitude. There are about 8000 ft of sedimentary rocks, which consist mostly of sandstone, siltstone, claystone, mudstone, and limestone. These rocks range in age from Pennsylvanian to Recent. Sandstone makes up about 30 percent of the rocks and comprises the principal aquifers in the region. The mudstone and claystone are impermeable to water and form the confining media which hydraulically separate the water-bearing formations.

There are a number of sandstone aquifers in the

region from which ground water can be developed. In ascending order, these consist of the DeChelly sandstone member of the Cutler formation and the equivalent Coconino sandstone, of Permian age, the Wingate sandstone and Navajo sandstone of Early Jurassic (?) age, the Entrada and Cow Springs sandstones of Late Jurassic age, the upper part of the Morrison formation of Late Jurassic age, the Dakota sandstone of Cretaceous age, the sandstones of the Mesaverde group of Late Cretaceous age, and sandstone of Tertiary age. The DeChelly and Coconino, the Navajo, and the Mesaverde yield the largest amounts of water in the Navajo country. Sandstones of the DeChelly and Coconino constitute the most widespread aquifer. However, development of ground water is feasible only in a fourth of the area of its occurrence, owing to its great depth below the surface, beyond the practical reach of wells, and to the high content of sodium chloride in the water in the deeper parts of the structural basin. The Navajo sandstone is a large wedge-shaped deposit that occurs only in the northwestern part of the region and pinches out to the southeast. This aquifer is within the practical reach of wells, and the water is of excellent quality for domestic and stock purposes. The sandstones of the Meaverde group occur in the central and eastern parts of the region. Each of these sandstones is a separate aquifer, and in many areas they yield water of widely different quality. The best water is encountered near the recharge area, and as the water moves down dip toward the central portion of the basin it becomes highly mineralized.

In the Navajo country, the ground-water supplies are small when compared with the available supplies in such areas as southern Arizona and California. The problems of mineral contamination further reduce this usable amount to a half or a third of the amount of water available. Development of ground water for irrigation purposes is not feasible except in limited quantities for small garden plots. It seems desirable to obtain enough information to set up a "water budget"—an account of the disposition of all the rainfall—in order that information may be available on the total quantity of usable water, to serve as a basis for a stable economy for the Indian peoples in this region.

JOHN W. HARSHBARGER

U.S. Geological Survey  
Holbrook, Arizona

Received March 1, 1954.

## Mesozoic Charophyta

THE Charophyta are green algae that live in quiet bodies of fresh or brackish water. They are common plants of world-wide distribution but are of little economic value and are not well known, even among botanists. Some species secrete calcite within the cells and have contributed extensively to nonmarine marl and limestone formation. On the death of the plant, the vegetative parts become broken and entangled, or the calcite disintegrates into a fine-grained mud, but the gyrogonites—the minute, sinistrally spiraled, ovoid

bodies that represent the calcareous portion of the oogonia—are often preserved in abundance and are stratigraphically important fossils.

The oldest gyrogonites known are from rocks of Early Devonian age in Podolia (western Ukraine). All Devonian and Mississippian forms are composed of vertical units (*Sycidium*) or dextrally spiraled units (*Trochiliscus*). Post-Mississippian gyrogonites are sinistrally spiraled and, with the one exception of the Pennsylvanian *Paleochara*, consist of five units. By early Mesozoic time, the charophytes were apparently a well-established and standardized group and have undergone relatively little change in the Mesozoic and Cenozoic eras.

Charophyte records in the early Mesozoic are sparse and widely scattered. A few forms have been described from various Triassic and Lower and Middle Jurassic localities, but the oldest abundant gyrogonites in North America are from the Morrison formation of Late Jurassic age of the Rocky Mountain area. Gyrogonites are also common in the Lower Cretaceous rocks (Aptian) of the Gulf Coast and the Rocky Mountain area and in the Lower Cretaceous Bear River formation of southwestern Wyoming. In Europe, charophytes have been described from the Kimmeridgian of northern Germany, the Purbeck of England and Northern Europe, and the Aptian of central Hungary. Charophyta from the nonmarine Late Cretaceous are not well known, but they are again common in nonmarine rocks of the Cenozoic era.

Gyrogonites are abundant in the limestones and calcareous shales of the Salt Wash sandstone and Brushy Basin shale members of the Morrison formation in the Colorado Plateau. They are also abundant in the calcareous beds of the undifferentiated Morrison formation along the eastern flank of the Front Range in Colorado and in outcrop areas in New Mexico, Oklahoma, eastern Wyoming, South Dakota, and central Montana.

The gyrogonites from the Morrison are small, averaging about 450  $\mu$  in length, and none has been found enclosed in the utricle characteristic of the Lower Cretaceous family Clavatoraceae. Species occurring in the Brushy Basin shale member and not in the Salt Wash sandstone member are present in the northern and eastern outcrops of undifferentiated Morrison. In central Colorado, eastern Wyoming, and the Black Hills region, thin beds of limestone in the Morrison formation consist largely of broken and entangled vegetative parts of charophytes, but to date it has been impossible to associate these remains with the gyrogonites.

Most of the gyrogonites in the nonmarine Lower Cretaceous formations are enclosed in utricles. These forms belong to the Clavatoraceae and, because of their wide distribution and easily recognized characteristics, are excellent guide fossils. The genera *Clavator* and *Atopochara* attained almost world-wide distribution in Lower Cretaceous time.

The utricle-bearing gyrogonites of the Clavatoraceae are not known from the Lower Cretaceous Bear River formation, or from any formation of Late Cretaceous

age. The Bear River charophytes fall readily into three specific categories, each species representing a different genus. Two species are ancient representatives of the modern genera *Tolyella* and *Chara*, and one species belongs to the extinct genus *Aclistochara*.

A monographic treatment of the Mesozoic Charophyta of North America is under preparation.

RAYMOND E. PECK

U.S. Geological Survey  
Columbia, Missouri

Received March 1, 1954.

### Contamination of Photographic Emulsion Caused by Beta-Active Dust

In the scanning of 16 cm<sup>3</sup> of G-5 emulsion (1 by 3 in. Ilford plates, 400  $\mu$  thick, emulsion no. Z 6278) flown in July, 1952, for 8 hr at balloon altitudes, the beta-active speck reproduced in Fig. 1 has been found.

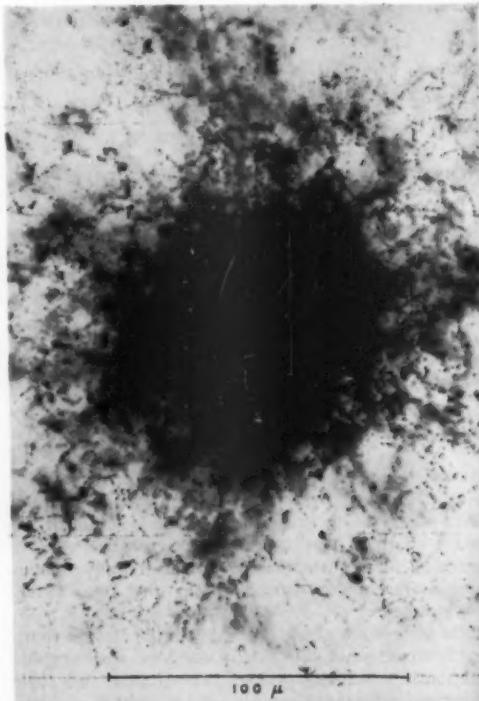


FIG. 1. Beta-active speck found in photographic emulsion.

The speck is similar to that recently described by Yagoda (1). The center of the speck is at 100  $\mu$  from the air surface of the developed emulsion, and at 40  $\mu$  from the glass surface. The black core has a diameter of  $\sim 25 \mu$ , and the total number of beta particles emerging from it has been estimated to be around

1000. The longest beta rays have a range in the emulsion of  $350 \mu$  equivalent to an energy of  $\sim 0.4$  Mev; no alpha particles were recognizable.

The time that elapsed between the pouring of the emulsion in England and the developing in Ithaca was 23 days. Since the package containing the plates was airtight, the speck was very likely present in the original emulsion.

As pointed out by Yagoda, this kind of speck is probably due to radioactive dust produced by nuclear explosions and carried far away by the winds. Undoubtedly, many more cases similar to this will be found by other researchers, because radioactive dust is already spread everywhere in the world. The frequency of these specks in all photographic materials will certainly increase in the future, unless the emulsion manufacturers take special precautions in selecting chemicals and water that are free from atmospheric dust.

CAROL SIENKO  
GIUSEPPE COCCONI

Laboratory of Nuclear Studies  
Cornell University  
Ithaca, New York

Reference

1. H. Yagoda. *Nature* 173, 79 (1954).

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## Further Light on the Roberts Thrust, North-Central Nevada

ALTHOUGH little detailed mapping has been done in eastern Nevada, reconnaissance suggests that the classic Eureka section, long ago described by Walcott and Hague, is broadly representative of the pre-Carboniferous strata of most of the eastern Great Basin. Except for the remarkably persistent and uniform Eureka quartzite of Middle Ordovician age, the strata from Middle Cambrian to Upper Devonian consist almost wholly of carbonate rocks.

At more westerly localities, a clastic facies of Lower Ordovician rocks has long been known. But the work of Merriam and Anderson (1942) was the first to disclose that the clastic facies has been thrust over the carbonate facies in the Roberts Mountains, about 20 mi northwest of Eureka. The facies distribution requires that the overriding block moved relatively eastward.

Merriam and Anderson mapped several windows in the folded thrust, in each of which the carbonate facies is well exposed beneath the overriding clastic rocks of Ordovician age. This demonstrated a width of at least 20 mi for the thrust fault—a minimum figure of displacement, because there is no convergence in facies of overriding and overridden strata.

The known breadth of the Roberts thrust was in-

creased by another 15 mi in 1949, when the fault was recognized in the Cortez quadrangle, northwest of the Roberts Mountains, by J. C. Crowell, C. A. Nelson, and James Gilluly.

Since 1950, work of the Geological Survey in the Mount Lewis quadrangle just northwest of Cortez has disclosed three other windows through the Roberts thrust. Carbonate rocks of Cambrian, Ordovician, and Silurian ages are exposed in these windows. The clastic rocks of the overriding plate include representatives of Silurian and Middle Devonian ages as well as of Lower and Middle Ordovician. The thrust surface separating the two facies is highly folded and indeed locally overturned, so that rocks of the window rest on rocks of the overriding plate. There is, however, nowhere a doubt as to whether a particular body of rock belongs to the eastern or western facies. There is no evidence of transition between the two, except perhaps that Silurian rocks in the most westerly window show a slight increase in clastic material.

The distinction in facies between overriding and overridden plates is emphatic in both Devonian and Ordovician: there is no question that we are dealing with a major thrust. With this extension, the known width of the Roberts thrust from the eastern Roberts Mountains to the Mount Lewis quadrangle becomes at least 45 mi.

The work of Ferguson, Roberts, and Muller has demonstrated huge thrusts still further to the west. These are of at least three ages: post-Mississippian to pre-Atoka, post-Leonard to pre-Phosphorin, and post-Triassic. Although the supposed Mississippian rocks may actually be considerably older, the pre-Atoka thrusts definitely involve rocks of Ordovician age. (No Silurian or Devonian units have been recognized by these workers.) None of these thrusts expose rocks of the eastern (carbonate) facies, although they do involve clastic Ordovician rocks like those of the upper plate of the Roberts thrust. It is inferred that the root zone of the Roberts thrust lies buried beneath the alluvium of the Reese River Valley near Battle Mountain and for at least 20 mi. to the south.

Information is still inadequate to fix the age of the Roberts thrust. In the Mount Lewis quadrangle allochthonous rocks as young as Permian and perhaps as young as Triassic rest on parts of the upper plate and are, in turn, overridden by Ordovician clastics. But whether the late Paleozoic and Mesozoic rocks have participated in the entire movement of the thrust or have been later thrust out on an older fault plate is not quite certain. Further work planned for the Crescent Valley quadrangle may throw light on this problem.

JAMES GILLULY

U.S. Geological Survey  
Denver Federal Center, Denver, Colorado

Received March 1, 1954.

## Book Reviews

*Progress in Organic Chemistry*, Vol. II. J. W. Cook, Ed. New York: Academic Press; London: Butterworths, 1953. 212 pp. \$7.00.

Volume 2 of *Progress in Organic Chemistry* consists of the following six chapters: Recent Developments in Theoretical Organic Chemistry, M. J. S. Dewar; Organic Fluorine Compounds, M. Stacey; Chemistry of the Triterpenoids, D. H. R. Barton; Partial Synthesis of Cortisone and Related Compounds from Accessible Steroids, F. S. Spring; Relationship of Natural Steroids to Carcinogenic Aromatic Compounds, H. H. Inhoffen; and Recent Developments in Pyridine Chemistry, J. P. Wibaut.

The chapters vary in length from 20 to 36 pages; the references cited vary in number from 17 in the first chapter to 172 in the sixth. The individual chapters serve their intended purpose of familiarizing the nonspecialist reader with current accomplishments and problems in the fields of chemistry covered, and the reviewer, as one such reader, expresses his thanks to the authors and editors.

To these thanks he would add one suggestion and one protest. The suggestion is that each chapter begin with a brief table of contents that would list the various subtopics to be discussed. The protest is against the practice of using chemical formulas instead of names in the text; for example, "IF<sub>5</sub> converted CBr<sub>4</sub> into a mixture of bromofluoromethanes and with Cl<sub>2</sub> there was obtained the useful substance CF<sub>3</sub>I, in good yield."

A. H. BLATT

Department of Chemistry, Queens College

*Les Protéines. Rapports et discussions*. Neuvième Conseil de Chimie tenu à l'Université de Bruxelles du 6 au 14 avril 1953. Sous les auspices du Comité Scientifique de l'Institut International de Chimie Solvay. Bruxelles: R. Stoops, 1953. 350 pp. Illus.

The University of Brussels and the Institut International de Chimie Solvay are host every third year to a conference on some aspect of chemistry. The ninth Solvay Conference, held in April 1953, was devoted to a consideration of protein chemistry. Nine prepared papers and the ensuing discussions by the invited participants have been beautifully published in this volume.

K. O. Pedersen presents a brief, critical discussion of the problems involved in the determination of molecular weights of proteins by osmotic pressure, ultracentrifuge, light scattering, and chemical methods. This paper includes tabulated data on 165 molecular weight determinations on various proteins and an extensive bibliography.

The paper of Linus Pauling is a discussion of proposed configurations of polypeptide chains in proteins. Consideration of x-ray diffraction data and known bond lengths and angles leads to the formula-

tion of detailed helical structures for polypeptide chains, and to suggested associations of these helices into multiple strand cables and fibers in proteins.

The third paper by Lawrence Bragg is a delightfully readable account of the problems involved in the analysis of the x-ray diffraction data for hemoglobin. In the interpretation of x-ray data, the cautious conservatism of the physicist is in interesting contrast to the optimistic precision of the chemist in the preceding paper.

In his paper Chibnall considers the chemical constitution of proteins. After a brief review of amino acid analysis, the author discusses the problem of determining the number of peptide chains in the protein molecule. Methods for N-terminal residues, C-terminal residues, and terminal amide residues are considered as is the evidence of cyclic peptide chains. The separation of the component peptide chains of proteins and the determination of amino acid sequences in these chains are discussed.

The paper of Syngle is a consideration of the merits of various methods for the separation in pure form of relatively large fragments of proteins as a preliminary to detailed analysis of these fragments. Electrophoresis, chromatography, and diffusion are among the methods discussed in a paper which is suggestive of possible methods awaiting exploitation in this field.

The sixth paper by Desreux and Frederiq is devoted to the fractionation and purification of proteins and criteria of purity. The separation of proteins from organized biological materials and the problem of association and dissociation of proteins are considered. Purification by solubility, electrophoresis-convection, adsorption, and distribution methods are discussed. The need for additional, more general methods is emphasized.

A discussion of protein denaturation along classical and familiar lines is given by Anson. It is remarkable how little advance has been made in this field in recent years, in contrast to the rapid progress in other aspects of protein chemistry.

The degradation of proteins by enzymes is considered by Linderstrom-Lang. The major portion of the paper is devoted to kinetic treatment of a number of hypothetical cases of proteolysis. This is followed by a discussion of experimental studies of protein-enzyme interactions including peptic and trypsin hydrolysis of various purified proteins and the transformation of ovalbumin into plakalbumin.

The last paper by Theorell is devoted to experimental evidence about the chemical relations between proteins and prosthetic groups. Included are discussions of flavoproteins, pyridine nucleotide proteins, and hemoproteins, with emphasis on the effects of specific proteins on the properties of the prosthetic groups.

This book presents a broad picture of present knowledge of the structural chemistry of proteins.

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The authors have in most cases attempted to predict future developments and to suggest specific fields in which work is needed. The restricted size of the papers is compensated by extensive bibliographies. The paper of Desreux and Frederiq and some of the discussions are in French, the rest of the book being in English. The book is well printed and bound, on good paper, and contains no more typographical errors than might be expected. It should be of considerable interest to students majoring in biochemistry and to anyone concerned with the various aspects of protein structure.

MARK H. ADAMS

Department of Microbiology  
New York University Bellevue Medical Center

## Books Reviewed in THE SCIENTIFIC MONTHLY

### January

**Galileo Galilei. Dialogue on the Great World Systems.** In the translation of T. Salusbury. Revised and annotated by Giorgio de Santillana. Chicago: Univ. Chicago Press, 1953. 506 pp. Illus. \$12.50.  
Reviewed by Raymond J. Seeger.

**Galileo Galilei. Dialogue Concerning the Two Chief World Systems—Ptolemaic & Copernican.** Trans. by Stillman Drake. Berkeley: Univ. California Press, 1953. 496 pp. \$10.00.

Reviewed by Michael B. Shimkin.

**Fundamentals of Biology.** W. J. Harbaugh and A. L. Goodrich, Eds. New York: Blakiston, 1953. 611 pp. Illus. \$6.00.  
Reviewed by Edward S. Castle.

**Franz Boas: The Science of Man in the Making.** Melville J. Herskovits, New York: Scribner, 1953. 131 pp. \$2.50.  
Reviewed by Robert H. Lowie.

**Squaring the Circle and Other Monographs.** E. W. Hobson et al. New York: Chelsea, 1953. 361 pp. Illus. \$3.25.  
Reviewed by N. T. Gridgeman.

**The Revolution in Physics.** Louis de Broglie. Trans. by Ralph W. Niemeyer. New York: Noonday Press, 1953. 310 pp. \$4.50.  
Reviewed by G. Gamow.

**Studies in Econometric Method.** Wm. C. Hood and Tjalling C. Koopmans, Eds. New York: Wiley, 1953. 323 pp. Illus. \$5.50.  
Reviewed by J. E. Morton.

**Plough and Pasture: The Early History of Farming.** E. Cecil Curwen and Gudmund Hatt. New York: Schuman, 1953. 329 pp. Illus. + plates. \$5.00.  
Reviewed by E. Adamson Hoebel.

**Algal Culture from Laboratory to Pilot Plant.** John S. Burlew, Ed. Washington, D.C.: Carnegie Institution, 1953. 357 pp. Illus. \$1.25, paperbound.  
Reviewed by Lewis Hanford Tiffany.

**American Constitutional Custom.** Burleigh C. Rodick. New York: Philosophical Library, 1953. 244 pp. \$4.75.  
Reviewed by Philip B. Perlman.

**Prehistoric Settlement Patterns in the Virú Valley, Peru.** Gordon R. Willey. Washington, D.C.: Government Printing Office, 1953. 453 pp. Illus. + maps and plates. \$4.00.  
Reviewed by Julian H. Steward.

**Life on the Earth.** Rose Wyler and Gerald Ames. New York: Schuman, 1953. 143 pp. Illus. \$2.50.  
Reviewed by John Tyler Bonner.

**Climate, Vegetation and Man.** Leonard Hadlow. New York: Philosophical Library, 1953. 288 pp. Illus. \$4.75.  
Reviewed by C. W. Thornthwaite.

**Brown Coal: Its Mining and Utilization.** P. L. Henderson, Ed. Melbourne, Australia: Melbourne Univ. Press; New York: Cambridge Univ. Press, 1953. 351 pp. Illus. \$7.50.  
Reviewed by Arno C. Fieldner.

**The Study of Human Nature.** David Lindsay Watson. Yellow Springs, Ohio: Antioch Press, 1953. 262 pp. \$3.50.  
Reviewed by John Macdonald.

**Experimental Studies in Psychiatric Art.** E. Cunningham Dax. Philadelphia: Lippincott; London: Faber and Faber, 1953. 100 pp. Illus. \$5.00.  
Reviewed by Otto Billig.

**Twenty Years of Psychoanalysis.** Franz Alexander and Helen Ross, Eds. New York: Norton, 1953. 309 pp. \$3.75.  
Reviewed by Philip R. Lehrman.

### February

**Quackery in the Public Schools.** Albert Lynd. Boston: Atlantic-Little, Brown, 1953. 282 pp. \$3.50.  
Reviewed by George D. Stoddard.

**The Triumph of the Alphabet.** Alfred C. Moorhouse. New York: Schuman, 1953. 223 pp. Illus. + plates. \$4.00.  
Reviewed by I. J. Gelb.

**Railroad Engineering.** Vol. 1. William W. Hay. New York: Wiley; London: Chapman & Hall, 1953. 483 pp. Illus. + charts. \$7.50.  
Reviewed by Charles F. Peck, Jr.

**A Survey of Modern Algebra.** Rev. ed. Garrett Birkhoff and Saunders MacLane. New York: Macmillan, 1953. 472 pp. Illus. \$6.50.  
Reviewed by L. M. Graves.

**A Refresher Course in Mathematics.** F. J. Camm. New York: Emerson, 1953. 240 pp. Illus. \$2.95.  
Reviewed by Helen G. Russell.

**Infinity.** Lillian R. Lieber. New York: Rinehart, 1953. 359 pp. \$5.00.  
Reviewed by S. B. Myers.

**The Philosophy of Nature.** Andrew G. Van Melsen. Pittsburgh, Pa.: Duquesne Univ. Press, 1953. 253 pp. \$4.50, cloth; \$3.75, paper.  
Reviewed by I. Bernard Cohen.

**Science in Synthesis.** William H. Kane et al. River Forest, Ill.: Dominican House of Studies, 1953. 289 pp. \$3.50.  
Reviewed by I. Bernard Cohen.

**In Spite of.** John Cowper Powys. New York: Philosophical Library, 1953. 312 pp. \$5.00.  
Reviewed by May Brodbeck.

**The Interpersonal Theory of Psychiatry.** Harry Stack Sullivan. New York: Norton, 1953. 303 pp. \$5.00.  
Reviewed by John R. Reid.

**Groups in Harmony and Tension.** Muzafer Sherif and Carolyn W. Sherif. New York: Harper, 1953. 316 pp. Illus. + plates. \$3.50.  
Reviewed by J. R. Kantor.

**Nationalism and Social Communication.** Karl W. Deutsch. Boston: Technology Press, MIT; New York: Wiley, 1953. 292 pp. Illus. \$5.00.  
Reviewed by Halford L. Hoskins.

**Culture.** A. L. Kroeber and Clyde Kluckhohn. Cambridge, Mass.: Harvard Univ. Press, 1952. 228 pp. \$5.25.  
Reviewed by Leslie A. White.

**Culture Change. An Analysis and Bibliography of Anthropological Sources to 1952.** Felix M. Keesing. Stanford: Stanford Univ. Press; London: Oxford Univ. Press, 1953. 242 pp. \$4.00.  
Reviewed by Georg K. Neumann.

**Volcanoes as Landscape Forms.** Rev. ed. C. A. Cotton. New York: Wiley, 1952. 416 pp. Illus. \$9.00.  
Reviewed by James Gilluly.

**America's Ancient Civilizations.** A. Hyatt Verrill and Ruth Verrill. New York: Putnam, 1953. 334 pp. Illus. + plates. \$5.00.  
Reviewed by James B. Griffin.

**Fossil Plants of the Florissant Beds, Colorado.** Harry D. MacGinitie. Washington, D.C.: Carnegie Institution, 1953. 198 pp. Illus. + plates. \$5.25, paper; \$5.75, cloth.  
Reviewed by C. A. Arnold.

**Evolution in Action.** Julian Huxley. New York: Harper, 1953. 182 pp. Illus. \$2.75.  
Reviewed by Bentley Glass.

**Elements of Heat Treatment.** G. W. Enos and W. E. Fontaine. New York: Wiley, 1953. 286 pp. Illus. \$5.00.  
Reviewed by George G. Lamb.

**The Whooping Crane.** Robert Porter Allen. New York: National Audubon Society, 1952. 246 pp. Illus. \$3.00.  
Reviewed by Albert Wolfson.

**Parental Care and Its Evolution in Birds.** S. Charles Kendige. Urbana: Univ. of Illinois Press, 1952. 356 pp. Illus. \$4.00, paper; \$5.00, cloth.  
Reviewed by Albert Wolfson.

**Great Men of Science.** Philipp Lenard. New York: British Book Centre, 1950. 389 pp. + plates. \$3.25.  
Reviewed by Garrett Hardin.

**Modern Nationalities.** Florian Znaniecki. Urbana: Univ. of Illinois Press, 1952. 196 pp. \$3.95.  
Reviewed by Edward A. Kennard.

**Hebrew Marriage.** David R. Mace. New York: Philosophical Library, 1953. 271 pp. \$6.00.  
Reviewed by Sol Tax.

**The Mammals of Minnesota.** Harvey L. Gunderson and James R. Beer. Minneapolis: Univ. Minnesota Press, 1953. 190 pp. \$3.50.  
Reviewed by Paul L. Errington.

**The Natural History of Infectious Disease.** 2nd ed. Macfarlane Burnet. New York: Cambridge Univ. Press, 1953. 356 pp. Illus. \$4.50.  
Reviewed by Gaylord W. Anderson.

**Plant Diseases, the Yearbook of Agriculture, 1953.** Washington, D.C.: U.S. Department of Agriculture, 1953. 940 pp. Illus. + color plates. \$2.50.  
Reviewed by A. J. Riker.

**Sex and the Nature of Things.** N. J. Berrill. New York: Dodd, Mead, 1953. 256 pp. Illus. \$3.50.  
Reviewed by Jane Oppenheimer.

**How to Know the Spiders.** B. J. Kaston and Elizabeth Kaston. Dubuque, Iowa: Wm. C. Brown, 1953. 220 pp. Illus. \$2.25, paper; \$3.00, cloth.  
Reviewed by A. M. Chickering.

**Reptiles and Amphibians.** Herbert S. Zim and Hobart M. Smith. New York: Simon and Schuster, 1953. 157 pp. Illus. \$1.50.  
Reviewed by Herbert L. Stahnke.

**Theoretical Anthropology.** David Bidney. New York: Columbia Univ. Press, 1953. 506 pp. \$8.50.  
Reviewed by Darryl Forde.

**The Tools of Social Science.** John Madge. London: Longmans Green, 1953. 308 pp. 25s.  
Reviewed by Mason T. Record.

**Letters on Art and Literature.** François Mauriac. New York: Philosophical Library, 1953. 120 pp. \$3.00.  
Reviewed by William J. McDonald.

**African Education.** The Nuffield Foundation and the Colonial Office. Oxford, Eng.: University Press, 1953. 187 pp. \$1.90.  
Reviewed by Charles S. Johnson.

**Science in Progress.** George A. Baitzell, Ed. New Haven: Yale Univ. Press, 1953. 285 pp. Illus. \$6.00.  
Reviewed by Joel H. Hildebrand.

**Research Operations in Industry.** David B. Hertz, Ed. New York: King's Crown Press, Columbia Univ., 1953. 453 pp. \$8.50.  
Reviewed by Jay N. Edmondson.

**New Screen Techniques.** Martin Quigley, Jr., Ed. New York: Quigley Pub., 1953. 208 pp. Illus. \$4.50.  
Reviewed by C. V. Starrett.

**A Bibliography on Meteorites.** Harrison Brown, Ed. Chicago: Univ. Chicago Press, 1953. 686 pp. \$10.00.  
Reviewed by John A. Russell.

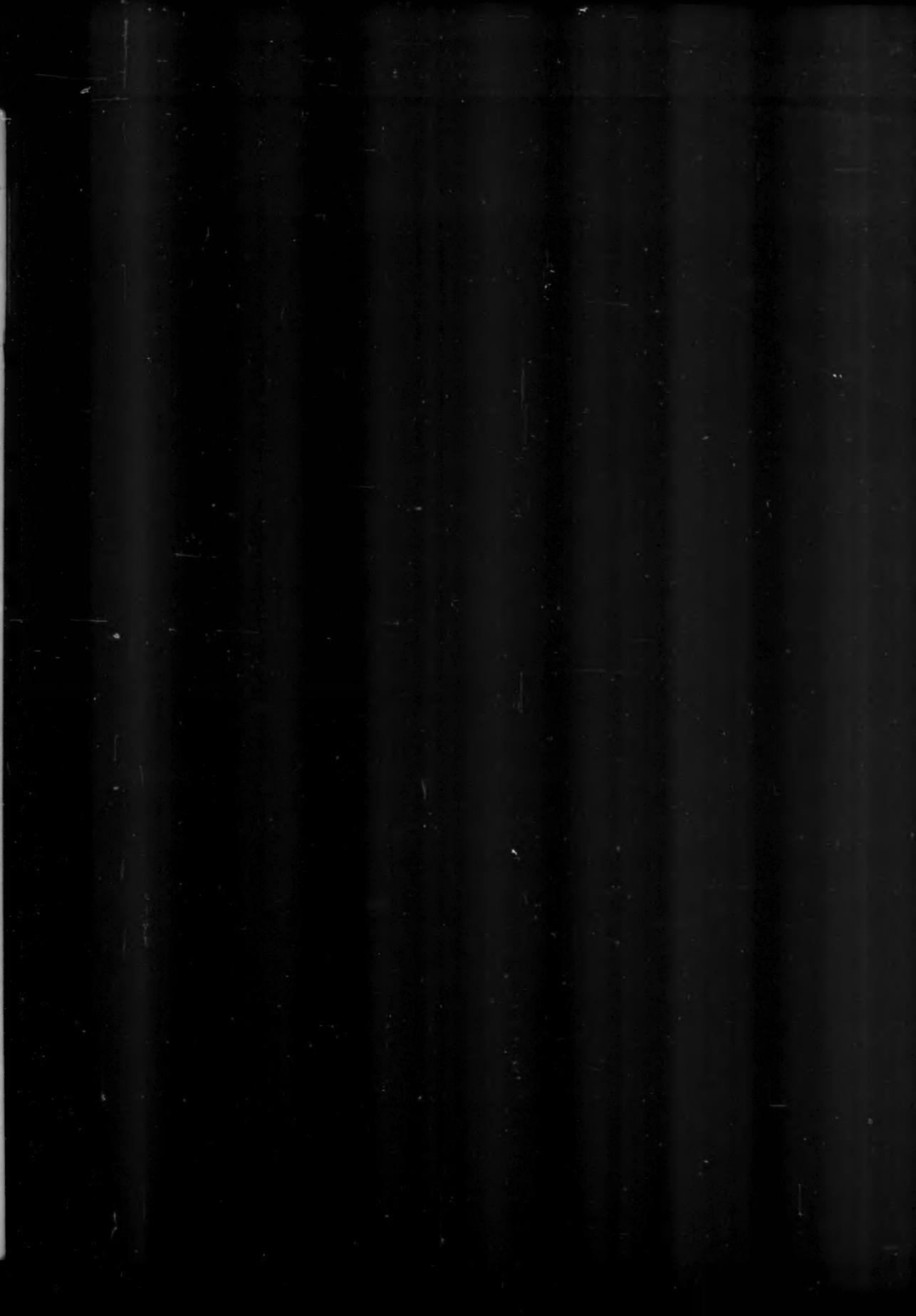
**Reviews of Research on Arid Zone Hydrology.** Paris: UNESCO; New York: Columbia Univ. Press, 1953. 212 pp. + maps. \$5.00.  
Reviewed by Walter T. Wilson.

**The Limits of the Earth.** Fairfield Osborn. Boston: Little, Brown, 1953. 238 pp. \$3.50.  
Reviewed by Roger Adams.

## March

**Atomic Medicine.** 2nd ed. Charles F. Behrens, Ed. Baltimore: Williams and Wilkins, 1953. 632 pp. Illus. \$11.00.  
Reviewed by Charles L. Dunham.







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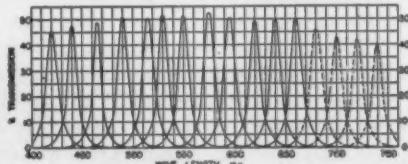
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Work on the *Bibliography* began in July 1947 under contract with the Office of Naval Research, with funds provided by the Departments of Army and Navy and an additional contribution from the Defense Research Board of Canada. Miss Marie Tremaine has served as editor and director of the project since its beginning. The Directing Committee consists of Burton W. Adkinson, Library of Congress; S. R. Galler, Office of Naval Research; Robert C. Gooch, Library of Congress; A. H. Lawton, Department of the Air Force; Paul Siple, Department of the Army; A. L. Washburn, Dartmouth College; Walter A. Wood, Arctic Institute of North America; Henry B. Collins, Smithsonian Institution (*chairman*). The work has been carried out mostly at the Library of Congress, which provides office space for the project, although the collections of the New York Public Library, Harvard University, the Smithsonian Institution, and some 60 other large libraries in the United States and Canada have also been utilized.

The first three volumes of *Arctic Bibliography*, of approximately 1500 pages each, have been issued by the Government Printing Office and are available for \$12.75 a set. These initial volumes list and summarize the contents of 20,000 of the more important publications in all fields of science relating to the arctic and subarctic regions of Alaska, Canada, Greenland, Siberia, and Europe.

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of March 3, 1879.

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Current work on the *Arctic Bibliography* is being conducted with the support of the Department of the Air Force. Volume 4 is in press and will appear probably in September. Material for Volume 5 is now being assembled. The 32,000 publications included in the three published and two forthcoming volumes are only a part of the vast literature on the Arctic. It is hoped that the work may continue, with an additional volume appearing annually to cover current publications as well as material not previously included.

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## Miscellaneous Publications

*Fundamental Research in the College of Engineering and Science.* Pittsburgh, Pa.: Carnegie Institute of Technology, 1953. 100 pp.

*Hydromedusae.* Great Barrier Reef Expedition 1928-29: Scientific Reports, Vol. VI, No. 4. P. L. Kramp. London, S.W.7, Eng.: British Museum (Natural History), 1953. 66 pp. Illus. £2.

*A Multitube Differential Pressure Manometer for Measuring the Average Flow of Fluids in Closed Ducts.* Bull. No. 410. G. B. Clark. 30 pp. Illus. 30¢. *The Dielectric Constant and Dissipation Factor of Soda-Potassia-Silica Glasses at Frequencies of 1 to 300 Kilocycles at Room Temperatures.* Bull. No. 411. G. F. Stockdale. 27 pp. Illus. 30¢. *Transport of Momentum, Mass, and Heat in Turbulent Jets.* Bull. No. 413. L. G. Alexander, Thomas Baron, and E. W. Comings. 88 pp. Illus. 75¢. Urbana, Ill.: Engineering Experiment Station, University of Illinois, 1953.

*Neutron Optics.* D. J. Hughes. New York: Interscience, 1954. 136 pp. Illus. \$2.50.

*New Worm Snake from Colombia, Genus Anomalepis.* Fieldiana: Zoology, Vol. 34, No. 17. Hyman Marx. 2 pp. 15¢. *The Elapid Genus of Snakes,* Walterinnesia. Vol. 34, No. 16. Hyman Marx. 8 pp. Illus. 20¢. *Hemprich's Coral Snake,* Micrurus hemprichi. Vol. 34, No. 13. Karl P. Schmidt. 6 pp. Illus. 15¢. *The Amazonian Coral Snake,* Micrurus spixii. Vol. 34, No. 14. Karl P. Schmidt. 10 pp. Illus. 25¢. Chicago, Ill.: Chicago Natural History Museum, 1953.

*Pasteur's and Tyndall's Study of Spontaneous Generation.* Case 7, Harvard Case Histories in Experimental Science. James Bryant Conant, Ed. Cambridge, Mass.: Harvard Univ. Press, 1953. 61 pp. Illus.

*Pedology of the Deniboota Irrigation District, New South Wales.* Soil Publ. No. 1. E. J. Johnston. Melbourne, Australia: Commonwealth Scientific and Industrial Research Organization, 1953. 92 pp. Illus.

*Plant Proteins in Child Feeding.* Medical Research Council, Special Report Series No. 279. R. F. A. Dean. London, Eng.: Her Majesty's Stationery Office, 1953. 163 pp. Illus. 22.25.

*Problem Book in the Theory of Functions,* Vol. I. Problems in the elementary theory of functions. Konrad Knopp; trans by Lipman Bers. 126 pp. Paper: \$1.25; cloth: \$2.50. *Problem Book in the Theory of Functions,* Vol. II. Problems in the advanced theory of functions. Konrad Knopp; Trans. by Frederick Bagemihl. New York: Dover, 1953. 138 pp. Paper: \$1.25; cloth: \$2.50.

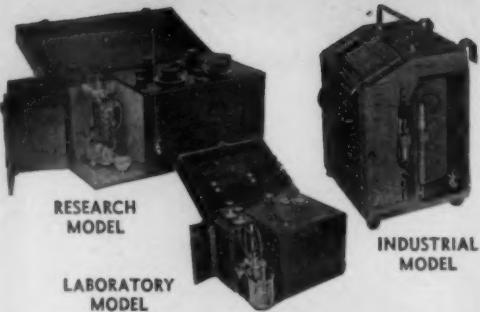
*Proceedings Volume of the Geological Society of America for 1952.* New York, N. Y.: Geological Society of America, 1953. 211 pp. Illus.

*The Resources of Leonardo da Vinci.* Papers delivered at Southern Illinois University, Nov. 12-15, 1952. George K. Plochmann, Ed. Carbondale, Ill.: Southern Illinois University, 1953. 39 pp. \$1.00.

*Thirty-Sixth Annual Report of the National Research Council of Canada, 1952-53.* No. 3033. Ottawa, Canada: N. R. C. of Canada, 1953. 54 pp.

*Toward a Regional Program of Psychological Research and Training in the South.* Atlanta, Ga.: Southern Regional Education Board, 1953. 97 pp.

*Triassic Life of the Connecticut Valley.* Bull. No. 81. 2nd ed. Revised by Richard Swann Lull. Hartford, Conn.: State Geological and Natural History Survey, 1953. 336 pp. Illus. \$2.00.



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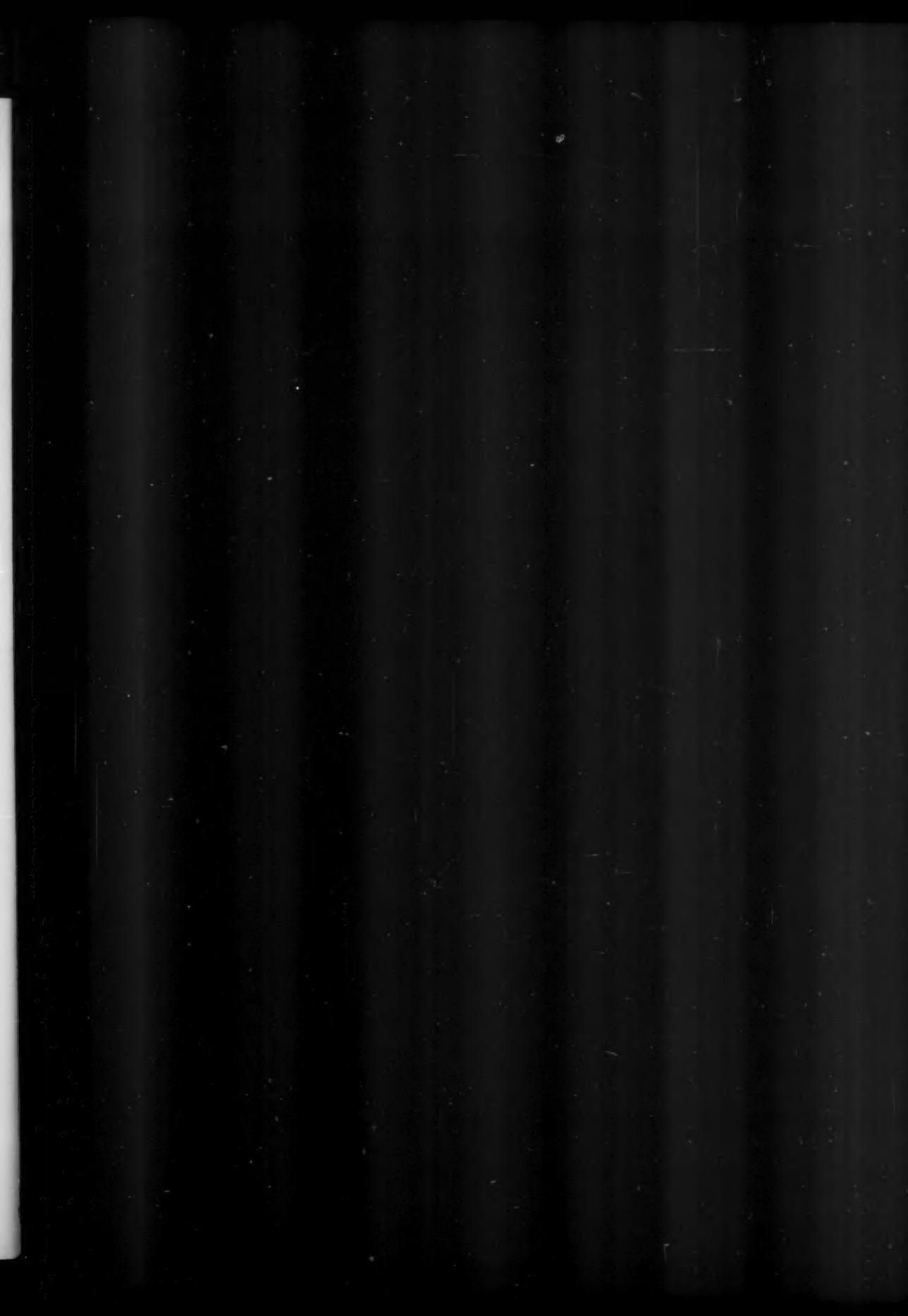
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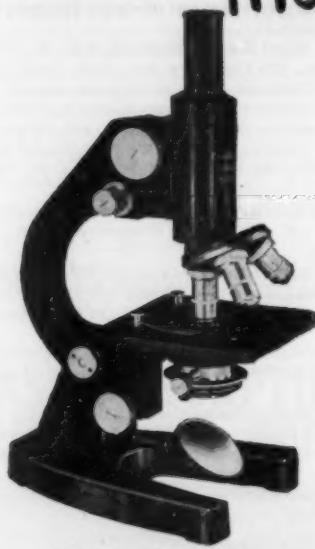




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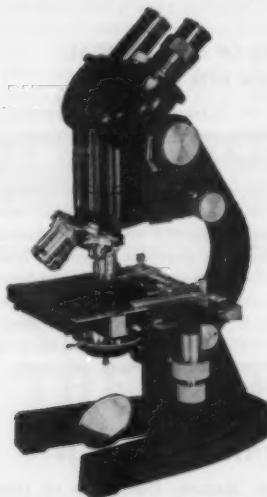
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## Meetings & Conferences

### April

15-14. Conf. on Applications of Computing Machines, Cleveland, Ohio. (F. C. Leone, 10900 Euclid Ave., Cleveland 6.)  
16-17. Histochemical Soc., Atlantic City, N.J. (R. D. Lillie, National Institutes of Health, Bethesda, Md.)  
18-22. American Assoc. for the Advancement of Science, Southwestern Division, Lubbock, Tex. (F. E. E. Germann, Dept. of Chemistry, Univ. of Colorado, Boulder.)  
20. Conf. on Instrumentation in Water, Sewage, and Industrial Waste Treatment, New York, N.Y. (Brother J. McCabe, Civil Engineering Dept., Manhattan College, New York 71.)  
23-24. Montana Acad. of Sciences, Missoula, Mont. (L. H. Harvey, Dept. of Botany, Montana State Univ., Missoula.)  
26-28. Metal Powder Show, Chicago, Ill. (Metal Powder Assoc., 420 Lexington Ave., New York 17, N.Y.)  
26-28. National Acad. of Sciences, annual, Washington, D.C. (Office of the Home Secretary, National Academy of Sciences, 2101 Constitution Ave., Washington, D.C.)  
26-30. American Soc. of Tool Engineers Industrial Exposition, 9th biennial, Philadelphia, Pa. (H. E. Conrad, 10700 Puritan, Detroit 21, Mich.)  
26-1. American Acad. of Neurology, annual, Washington, D.C. (F. M. Forster, Georgetown Univ., Washington, D.C.)  
26-2. Cong. of the International College of Surgeons, 9th biennial, São Paulo, Brazil. (Secretariat, International College of Surgeons, 1516 Lake Shore Dr., Chicago 10, Ill.)  
27-30. International Health Cong., Scarborough, Eng. (P. A. Wells, 90 Buckingham Palace Rd., London, S.W. 1, Eng.)  
29-30. Eastern States Health Education Conf., New York, N.Y. (I. Galdston, 2 E. 103 St., New York 29.)  
29-30. Symposium of Recent Advances in the Study of Venereal Diseases, 6th annual, Washington, D.C. (J. K. Shafer, Public Health Service Division of Venereal Diseases, Washington 25, D.C.)  
29-1. American Mathematical Soc., Chicago, Ill. (J. W. T. Youngs, Univ. of Indiana, Bloomington.)  
29-1. American Physical Soc., Washington, D.C. (K. K. Darrow, Columbia Univ., New York 27, N.Y.)  
29-1. Kansas Acad. of Science, annual, Hays, Kansas. (C. T. Rogerson, Dept. of Botany, Kansas State College, Manhattan.)  
29-1. Midwestern Psychological Assoc., Columbus, Ohio. (L. J. Cronbach, 1007 S. Wright, Champaign, Ill.)  
30-1. South Dakota Acad. of Science, annual, Rapid City, S. Dak. (A. L. Haines, Chemistry Dept., Univ. of South Dakota, Vermillion.)

### May

2-6. Electrochemical Soc., spring, Chicago, Ill. (H. B. Linford, Columbia Univ., New York 27.)  
2-7. Soc. of American Bacteriologists, annual, Pittsburgh, Pa. (F. S. Cheever, P.O. Box 1912, Pittsburgh 30.)  
3-5. American Geophysical Union, 35th annual, Washington, D.C. (J. Adkins, Office of Naval Research, Washington 25.)  
3-6. Air Pollution Control Assoc., Chattanooga, Tenn. (H. C. Ballman, 4400 5 Ave., Pittsburgh 13, Pa.)

(See the March 19th issue  
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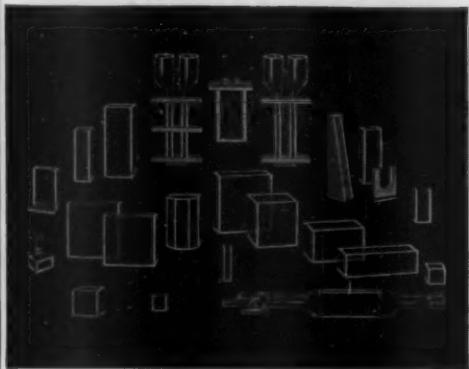
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